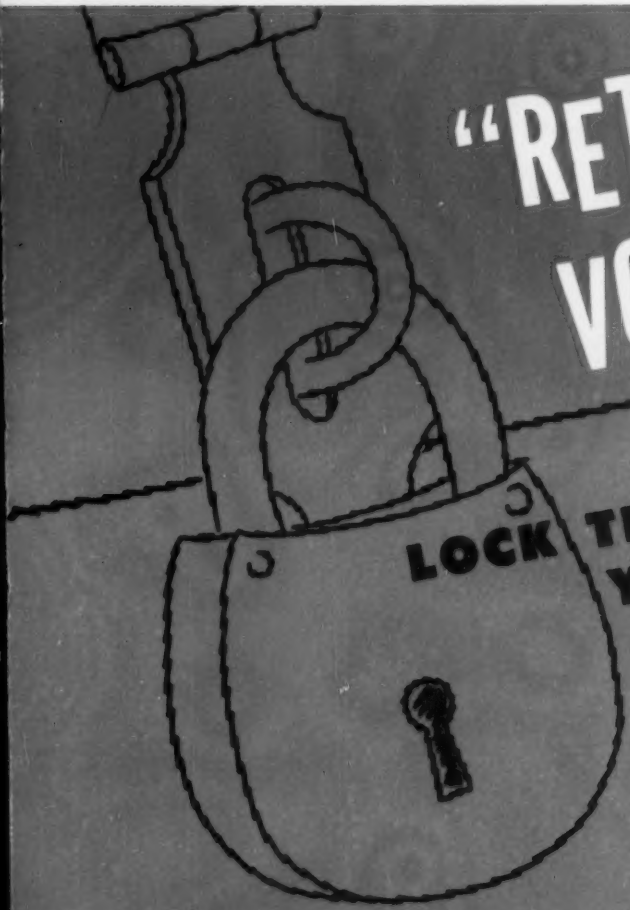
OCTOBER • 1955

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

- Compressor Aids, Pages 104-120
- Your Own Nomograms, Page 143
- New Design Method, Page 157
- Japan and Petrochemicals, Page 163



"RETAINED VOLATILITY"

LOCK THE PEP IN YOUR MOTOR FUEL

Blending with WARREN NATURAL GASOLINE is your best assurance that none of your Motor Fuel's high quality escapes before or after it gets into the customer's tank.

You can depend on Warren's production, transportation, storage and SERVICE for the grade and quantity of NATURAL GASOLINE you need — when and where you want it.

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

they never get tired!

• YARWAY Single-end Welding-type Gun-Pakt joint for 150 lbs. pressure.

• Some of the 189 YARWAY Gun-Pakt expansion joints installed at large oil refinery in Texas.

No fatigue with 189 YARWAY GUN-PAKT EXPANSION JOINTS at this large Texas refinery

THEY just work and work for years and never get tired. Yarway Gun-Pakt slip-type joints simply will not fail through fatigue. They will operate smoothly, as frequently as required, over long, full traverse up to 12″ single type or 24″ double type or short, partial traverse, day in and day out—with never any danger of metal fatigue or failure.

This is just one of the many big advantages found in Yarway Gun-Pakt expansion joints. Other outstanding Gun-Pakt features are:

1. Can be serviced under *full* steam pressure day and night, thus avoiding costly and inconvenient shutdowns.
2. Fixed Gun-Pakt gland serves as "built in" external guide and permits less costly and rigid pipe guidance than required by many other types of joints.
3. Lower pressure load on end anchors because excessive strains are eliminated.

Used for many years with success in well-known refineries, industrial plants, utilities and institutions. When replacing present joints or planning new steam lines, it will pay you to look into the advantages of the Yarway Gun-Pakt expansion joint. Write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
128 Mermaid Avenue, Phila. 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

gun-pakt expansion joints

Volume 34, No. 10 October, 1955

PETROLEUM REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

COMPRESSOR AIDS

How to Design and Operate Gas Jet Compressors 104
Frank H. Dotterweich and C. V. Mooney
Tailor Centrifugals to Your Conditions 110
C. F. Koenig and L. J. Holveck
Atmosphere Affects Air Blowers 116
W. A. Rostafinski

OTHER TECHNICAL FEATURES

Acids and Anhydrides from Petroleum 121
Lewis F. Hatch
How Contaminants Influence Design 125
B. J. Mayland, Robert M. Reed and Norman C. Updegraff
Heat Exchanger Design (Part 2) 129
Daniel A. Donohue
The Hoechst Continuous Coking Process 139
H. Krekeler
How Corrosion Causes Fatigue Failures 141
William G. Dudley and John J. McKetta
Nomograms . . . Make Your Own (Part I) 143
Francis W. Winn
Economics of Electrical Conductors 148
Herbert Argintar
This Process Makes Its Own Logsheet 149
Howard M. Mathis
Turbulent Two-Phase Flow 151
J. M. Chenoweth and M. W. Martin
Move Drums Easily 156
A. J. Bevevino
New Method for Pipe Stresses (Part I) 157
K. Hao Hsiao
The 5-Year Plan for Japan in Petrochemicals 163
Igor Oganesoff
Engine System of the Future 166
Can Lubricants Check Engine Deposits 167
C. A. Hall
Analog Computer Records Flow 173
Frank C. Smith, Jr.

As Management Sees It

Meeting the Postwar Products Demand 102
Howard B. Nichols
Oil Sampling Accidents Can Be Prevented 208
Here's the Formula for the Perfect Memo 210
Auren Uris
To Meet Engineer Shortage: Utilize Them! 220
Emmett G. Jackson

DEPARTMENTS

Quick Look 4
Mail Box 89
Quick Look at Industry . . . 93
Look Box 97
Valuable Reading Ahead . 178
How to Do It 180
Who's Building 184
Construction Boxscore . . . 198
What's Happening 230
Men in Industry 242
Heard at Meetings 268
Meetings Calendar 269
Suppliers' Notes 272
Reviewing New Books . . . 284
Classified Advertising . . . 288
New Equipment 291
New Literature 305
Index to Advertisers 306
Readers' Service Card . . . 307

A Quick Look at This Issue

These handy digests permit checking ✓ those articles you want to read first.

COMPRESSOR AIDS

☐ **How to Design and Operate Gas Jet Compressors . . .** Here is a low-cost method of putting relatively low-pressure gas into high-pressure lines. This device has no moving parts and is practically maintenance-free. It works on the venturi principle and has been tested in the field several years. You will enjoy this one on **Page 104.**

☐ **Tailor Centrifugals to Your Own Conditions . . .** and you will enjoy maximum flexibility and economy of operation. You must match carefully the known capabilities of the compressor with the requirements in your operations. These experts tell you the whole story in simple, down-to-earth language. **Page 110.**

☐ **Atmosphere Affects Air Blowers . . .** Improve your understanding of the behavior of your centrifugal air compressors. Here is a thorough and complete review of the factors and effects in performance. This is a must for those wanting to get that last dollar of profit through high efficiency operation of equipment. **Page 116.**

☐ **Acids and Anhydrides from Petroleum . . .** This discussion of the organic acids and anhydrides produced from petroleum raw materials covers their relative importance, the basic chemical reactions involved and the end use pattern. It is a thorough roundup of information on these important materials. **Page 121.**

☐ **How Contaminants Influence Design . . .** In any process design the effect of contaminants in the process fluids must be given serious consideration well in advance. These effects may be of such proportions as to make a given process uneconomical. Examples cited are indicative of some of the problems encountered. **Page 125.**

☐ **Heat Exchanger Design Part 2—Heat Transfer . . .** The second article in this informative series covers temperature difference, Δt correction

→ Now Turn the Page →

A Quick Look at This Issue

factors, fouling factors, and coefficient of heat transfer. Charts are presented for the rapid solution of the equations involved. **Page 129.**

☐ **The Hoechst Continuous Coking Process . . .** is supposed to yield a higher percentage of unsaturated hydrocarbons. The indirect heating of the coke pebbles results in the elimination of side-reactions which normally occur in direct heating. This fluid process is good for a wide variety of feed materials. **Page 139.**

☐ **How Corrosion Causes Fatigue Failures . . .** Did you know that wet steam produces only a trivial weight loss on 12 percent chromium stainless steel but will cut its endurance limit in half? Yes, and this article discusses what havoc can be wrought by a little corrosion combined with fatigue. Here are more hints on metal fatigue. **Page 141.**

☐ **Nomograms—Make Your Own . . .** A new series designed for you. Each of you has wanted to learn how to make these "complicated looking" nomograms. Here's your chance to actually make your own. The writer takes you by the hand through each step and shows you that making your own nomogram is really a simple thing. We think this series is the simplest presentation of nomography we have ever seen. You'll agree after you've had a chance to see **Page 143.**

☐ **Economics of Electrical Conductors . . .** Be sure to use this quick check method when you size conductors. It will make your company money and save you time. Review the derivation by turning to **Page 148.**

☐ **This Process Makes Its Own Logsheet . . .** Flows, pressures, and temperatures are simultaneously measured by this system. The measuring impulses are fed through a scanning and programming device, a converter and selector, and finally to automatic typewriters. Future installations are expected to add very little to the cost of instrumentation of processes. **Page 149.**

☐ **Try This New Correlation for Turbulent Two-Phase Flow for Gases and Liquids . . .** and you will get more accurate results. This correlation results from extensive studies on larger diameter pipe and at pressures up to 100 psia. At higher pressures the previous correlations always gave results for pressure drops as much as 2.5 times higher than those measured. This new correlation gets you right back on the ball ground. Here's another for your notebook. **Page 151.**

☐ **New Method for Pipe Stresses . . .** You'll find this method a big time saver in computing stresses in a three-dimensional piping system, as well as making the whole procedure much simpler. Compared to tedious conventional methods, this one will help you avoid common errors. The first part of this series shows you how to handle the tabular method and includes a complete example calculation. **Page 157.**

☐ **The Plan for Japan in Petrochemicals . . .** is a BIG 5-year plan. Although the chances for foreign participation in this expansion is slim, the possibility of sales of foreign equipment, material, and technical know-how is high. The present plan calls for expenditures of over $30 million. Production will more than double during the plan. Their petrochemical future is outlined. **Page 163.**

☐ **Can Lubricants Check Engine Deposits? . . .** The answer is yes. The role that the lubricant plays in the formation of combustion chamber deposits and their resultant effect on the octane number requirement for knock and surface ignition is covered. Tests indicate that the removal of heavy ends from lubricating oil tends to lessen requirement increase, but oil volatility is a more important factor than hydrocarbon composition of the oil. **Page 167.**

☐ **Analog Computer Records Flow . . .** Give those routine flow calculations to the analog computer. It may be installed to record flow directly and continuously. **Page 173.**

☐ **Meeting the Postwar Products Demand . . .** What oil companies are setting the pace in the postwar building program? Caltex is one. The story of this company's phenomenal growth is told on **Page 102.**

☐ **Oil Sampling Accidents Can Be Prevented . . .** Injuries while drawing off oil samples are costing the industry thousands of man hours daily. In this article some excellent safety methods are presented that will help eliminate such accidents. **Page 208.**

☐ **Here's the Formula for the Perfect Memo . . .** If you are interesetd in improving company communications, be sure to read this article in which a surefire formula is presented for writing effective memos. **Page 210.**

☐ **To Meet Engineer Shortage: Utilize Them! . . .** Many oil companies are hoarding engineers—keeping them in unimportant jobs until needed. The result is loss of perspective and sagging morale. For a plan that will help you get maximum performance from your engineering staff, see **Page 220.**

A great series of refinery postwar expansion starts on Page 102

PETROLEUM REFINER

RAY L. DUDLEY.....Publisher
A. L. BURNS.....General Manager
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
SILAS B. RAGSDALE.....Editorial Director
GEORGE B. GIBBS.....Editor
PAUL E. NICHOLLS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
DON E. LAMBERT.....Management and Personnel Editor
CECIL W. SMITH.....Economics Editor
HARRISON T. BRUNDAGE.....Eastern Editor
GILBERT M. WILSON.....Western Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
JOSEPH HOPKINS.....Presentation Editor
BILLINGS D. BARNARD.....Editorial Assistant

ADVERTISING

Tom W. Nelson, Advertising Manager; D. S. Craig, Advertising Service Manager. *Representatives:* NEW YORK (17): Gene Hart, George Skelton, Nelson Bigelow, 250 Park Ave., Phone El Dorado 5-4012; CLEVELAND (15): Bill Westfall, 1010 Euclid Ave., Phone MAin 1-2550; CHICAGO (4): H. G. Fitzpatrick, Martin Halloran, 332 So. Michigan Ave., Phone Wabash 2-9350; LOS ANGELES: Jay Curts, W. W. Wilson Bldg., Huntington Park, Phone Ludlow 7-1219; TULSA (3): Jim Isaacks, Hunt Bldg., Phone 3-1844; HOUSTON (6): Charles Wyatt, Wm. G. Dudley, 3301 Buffalo Drive, Phone JAckson 9-4301. EUROPEAN: Theodor Miocha, Limmerstrasse 31, Hanover, Germany, Phone 42935. UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2, Phone Monarch 5661.

SUBSCRIPTIONS

R. M. de Sombre, Circulation Manager, P. O. Box 2608, Houston 1, Texas, U.S.A.
Single copies 50 cents (except special issues) for U. S. and Canada; $1 for all other countries. Subscription rates—U. S. and Canada $2 a year; Latin America and overseas $5 a year. PETROLEUM REFINER, published on the 13th of every month, entered as second class matter June 16, 1923, at the post office at Houston Texas, under act March 3, 1879. Subscriptions restricted to those engaged in refining, natural gasoline or petrochemical industries or service and supply company personnel connected thereto. Advertising rates on application.

Copyright 1955 by The Gulf Publishing Company.

Cable address GULFPUBCO.

Specialized Oil Publication of
THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY for the oil and gas pipe line industry

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

For the Alert And Ambitious Man

COMMENT FROM a subscriber in El Paso brings up a topic that interests a lot of people who make PETROLEUM REFINER possible and that's none other than our advertisers. Listen to Mr. PR Reader:

"In the refinery storehouse, we are primarily interested in the equipment and materials used in a plant; consequently, of most interest to us are *the advertisements* (italics are ours) and articles dealing with such equipment."

One of our New York advertising men, recently in Houston, brought up the subject of advertisement reading and we told him that invited industry men at our editorial conferences almost invariably tell us that they comb PR's ads just about as carefully as they do the technical section. They explain that it's hard to keep abreast of developments unless they do check the ads on a careful and regular basis. And being bright, alert men and men who are forging ahead in their companies (else we wouldn't invite them to our conferences!), they feel they must keep right on top of what's going on industry-wise. So they read the ads.

It's as simple as that.

Those High Octanes

YOU MAY not want to tear into your copy of the September Process Issue of PETROLEUM REFINER so you can make a separate of "How to Get Those Top Octanes." Well, you won't have to, because we're issuing this 50-pager in reprint form and you can order as many as you need for $1 per copy. Just address Reprint Department, PETROLEUM REFINER, Box 2608, Houston 1, Texas, and inclose your check.

This article by Marshall Sittig and Wayne Warren of Ethyl Corporation presents a thorough treatment of octane improvement techniques besides relating a most authoritative and up-to-date comparison of catalytic reforming processes. It is a comprehensive monograph, one that should be in every process man's reference file.

At the Very Heart

TWO SUBJECTS which are at the very heart of furnace fuel economics will be presented in next month's Fired Heater Symposium. These include:

The latest thinking on hydrogen fuel-burner problems, and

A comprehensive analysis of the possibilities of firing furnaces with very heavy resid fuels

Also included will be applications information and thermal transfer data AND a special package for the natural gasoline plant designer and operator.

We know a big segment of PETROLEUM REFINER readers will be interested in these topics that will be presented along with an unusually good lineup of other technical features.

3:59.4 or 4:01.4

There's enough difference To make all the difference

A difference of only 2 seconds . . . but it made sports history on May 6, 1954, when the first under-four-minute mile was run in Oxford, England.

The differences in quality and performance that Scovill builds into its Heat Exchanger Tube, while they also may seem small, can make a *big* difference in improving your operating record. Scovill Phosphorized Admiralty Heat Exchanger Tube, for example, begins its long service life with an added advantage. It is initially hot-extruded from billets *continuous-cast* by Scovill's pioneer process. This means sounder metal — smooth, dense, free from pits or porosity. It means new uniformity of chemical composition, with optimum and uniformly distributed phosphorus content.

The next time you have a new installation or a re-tubing job, let us show you how these differences in Scovill Heat Exchanger Tube work for you.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

13BCSS

Activity stays high longer

Aerocat®

fluid cracking catalyst

Balanced with HI PV*

New higher pore volume in AEROCAT Fluid Cracking Catalyst is the key to its exceptional thermal and steam stability.

By increasing pore volume, Cyanamid has endowed this catalyst with activity that stays high longer in steam atmospheres and at high temperatures. High pore volume is carefully balanced with pore diameter and specific surface to achieve the ultimate in activity maintenance without sacrificing other desirable characteristics.

Cyanamid has pioneered this improved catalyst to boost cracking efficiency. Its superior performance is now backed by extensive commercial experience.

Ask your Cyanamid representative about HI PV and the contribution new AEROCAT Catalysts can make to your cracking operations.

*Trade-mark

AMERICAN Cyanamid COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

FLUID HYDROFORMER

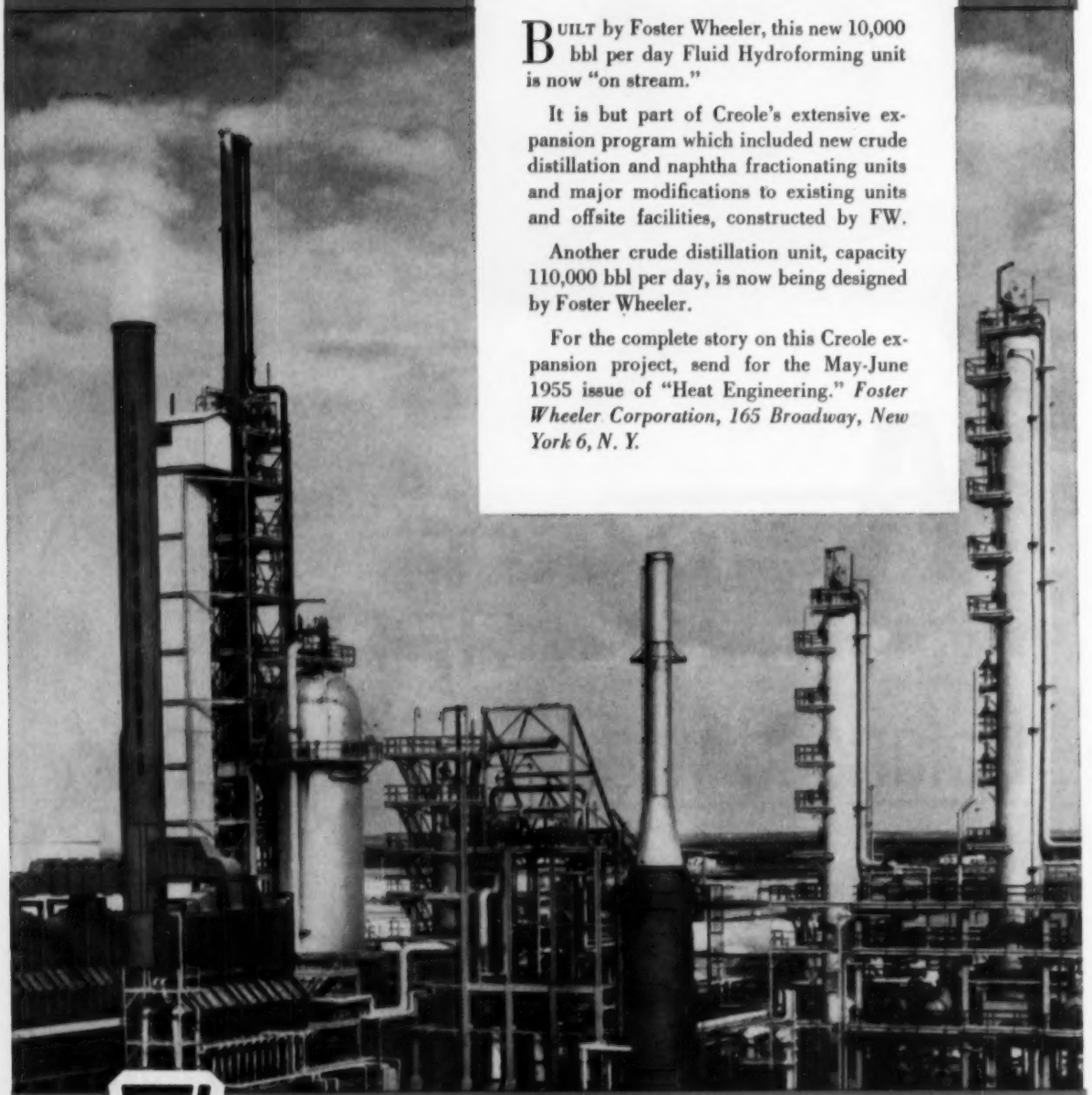
features expansion program at CREOLE'S Amuay Bay Refinery

BUILT by Foster Wheeler, this new 10,000 bbl per day Fluid Hydroforming unit is now "on stream."

It is but part of Creole's extensive expansion program which included new crude distillation and naphtha fractionating units and major modifications to existing units and offsite facilities, constructed by FW.

Another crude distillation unit, capacity 110,000 bbl per day, is now being designed by Foster Wheeler.

For the complete story on this Creole expansion project, send for the May-June 1955 issue of "Heat Engineering." *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*



FW FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

When it's Basic Chemicals for Petroleum...

...specify GENERAL CHEMICAL

ALKYLATION
Anhydrous Hydrofluoric Acid
Sulfuric Acid

POLYMERIZATION
Fluosulfonic Acid $HO:SO_2F$
Boron Trifluoride
Sulfuric Acid

SULFONATION
Sulfuric Acid
Sulfan® (Stabilized Sulfuric Anhydride)
Oleum

ISOMERIZATION
Muriatic Acid (Hydrochloric)

DETERGENTS & BUILDERS
Sodium Metasilicate
Disodium Phosphate
Sodium Sulfate, Anhydrous
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

ACIDIZING
Muriatic Acid (Hydrochloric)
Hydrofluoric Acid

MUD CONDITIONING
Sodium Silicate
Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

GREASE MAKING
Aluminum Sulfate

ACID TREATING
Sulfuric Acid
Sodium Silicate

Other Heavy Chemicals, catalysts, addition agents, inhibitors and special "tailor-made" chemicals.

B&A Laboratory Reagents and Fine Chemicals

Above photograph courtesy of QUAKER STATE OIL REFINING CORP.

Basic Chemicals for American Industry

Allied Chemical

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte Chicago • Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville Kalamazoo • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Providence San Francisco • Seattle • St. Louis • Yakima (Wash.)
In Wisconsin: General Chemical Company, Inc., Milwaukee
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

For more data on advertised products, use Readers' Service Cards, last page.

There's one right way to buy pressure tubes—it's tube life per dollar: *Ask the experts!*

This month's report is on: **DM STEEL**

Has unusually high creep strength for a pearlitic steel, good stability up to 1200° F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

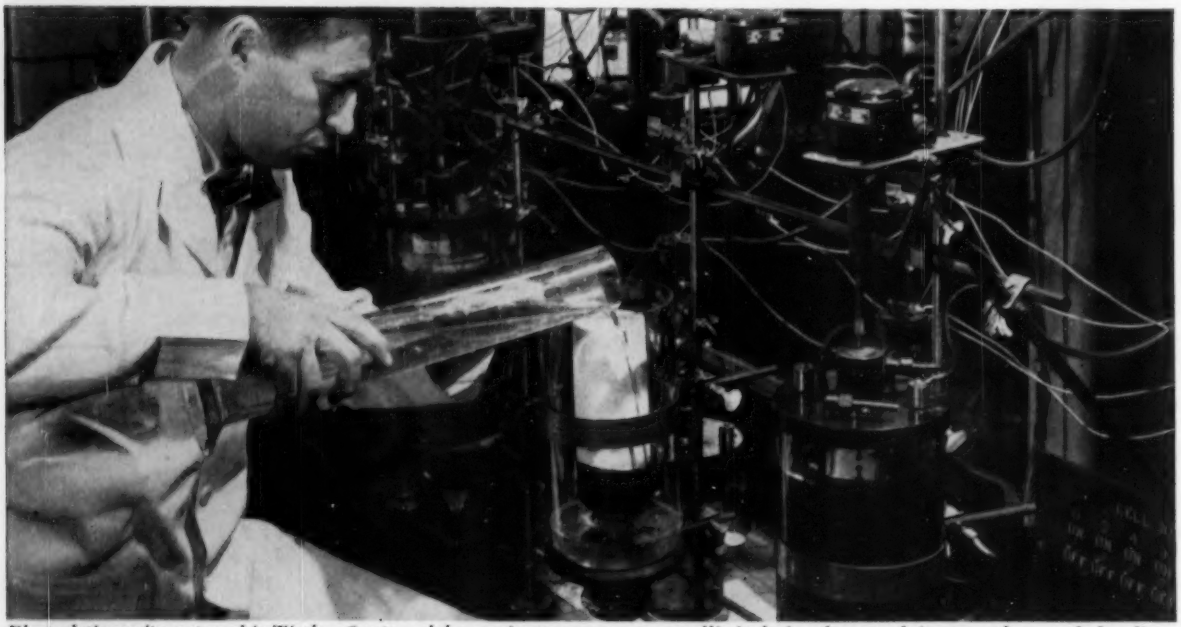
**Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

YOU'RE fortunate in having the Timken Company's large choice of high temperature tube steels that will solve your heat, pressure, corrosion and oxidation problems. You're even more fortunate when you choose the *one* analysis that will give you maximum tube life per dollar—the only true index to actual tube steel cost.

To find it, *ask the experts!*

These experts are the metallurgists of The Timken Roller Bearing Company. They'll put their more than 20 years of steel research and experience—with emphasis on high temperature steels—at your disposal. Help you select from 24 different analyses the one tube steel that will give you the best life/cost ratio. Regardless of which analysis you select, you'll be assured of uniform quality. Because the Timken Company rigidly controls quality from melt shop through final inspection.

Let the Timken Company's metallurgists help solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Electrolytic equipment used in Timken Company laboratories to extract non-metallic inclusions from steels in research on steel cleanliness

YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Here is

EXTRA MOTOR VALUE

Double-shielded bearing
Large grease reservoirs
Bolted-on bearing cap
Labyrinth seals

This Allis-Chalmers Bearing Design Gives More for Your Motor Dollar

You can lubricate these bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at two points provide means for inserting new grease, flushing out old grease and relieving pressure during re-greasing.

The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, minimizes the possibility of grease entering the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt barriers.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to give you the facts on this maintenance-saving design. Or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B7286. A-4855

ALLIS-CHALMERS

NOW!

Electronic LIQUID LEVEL CONTROL by FISHER®

Fisher Governor Company widens its scope of liquid level measurement and control with the Fisher "Belmont Series" of capacitance type electronic liquid level controllers.

The "Belmont" can be used on most non-adhesive liquids—chemicals, oil, water, refrigerants, liquefied gases. Operating temperature ranges of the sensing elements are from 500° F. to -425° F. Operating pressure range is vacuum to 50,000 psi or higher.

Only two simple adjustments for liquid and differential control.

Fisher Governor Company has purchased the Thermo Instruments Company, Belmont, California, which has manufactured and marketed the "Belmont" liquid level control the past ten years.

Write for Bulletin F-100

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER

Our 75th ANNIVERSARY

CAN TYPE VERTICAL PUMP

Now Available in Two Types—FOR APPLICATION to CHEMICAL PROCESSING, REFINING TECHNIQUES, CONDENSATE SERVICE, AND LINE BOOSTER SERVICE

NEW DESIGNS PROVIDE BOTH A PROCESS TYPE AND A TRANSFER TYPE

The process type vertical Hydro-Line pump, especially suited to refining and process pumping offers the following features—1) API-ASME code welding; 2) especially designed containers for either mechanical shaft seals or packing; 3) availability of head and barrel flanges up to 300 lbs. or more; 4) extra heavy wall thicknesses for maximum stability and high safety factor; 5) elliptical barrel bottom design for optimum fluid entrance conditions. The transfer type Hydro-Line pump is of a similar design to the process type differing in materials of construction required for less rigorous service. Both types are extremely flexible in installation, are easy to inspect, service and maintain—can be designed for operation on any available system NPSH. Write for new Bulletin No B-1700.

THE PEERLESS
HYDRO-LINE
ENCASED CLOSE-COUPLED PUMP

CAPACITIES TO	3000 gpm
HEADS TO	1000 feet
DRIVES	As required, vertical solid shaft, or explosion-proof motors; steam turbine.
TEMPERATURES	Up to 400° F.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Factories at: Los Angeles, Calif., and Indianapolis, Ind.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis; Phoenix; Fresno; Los Angeles; Dallas, Plainview and Lubbock, Texas; Albuquerque, New Mexico.
Distributors in Principal Cities; Consult your Telephone Directory.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
301 West Avenue 26, Los Angeles 31, California

Please send me a copy of Peerless Hydro-Line Pump Bulletin No. B-1700.

NAME _____

ADDRESS _____

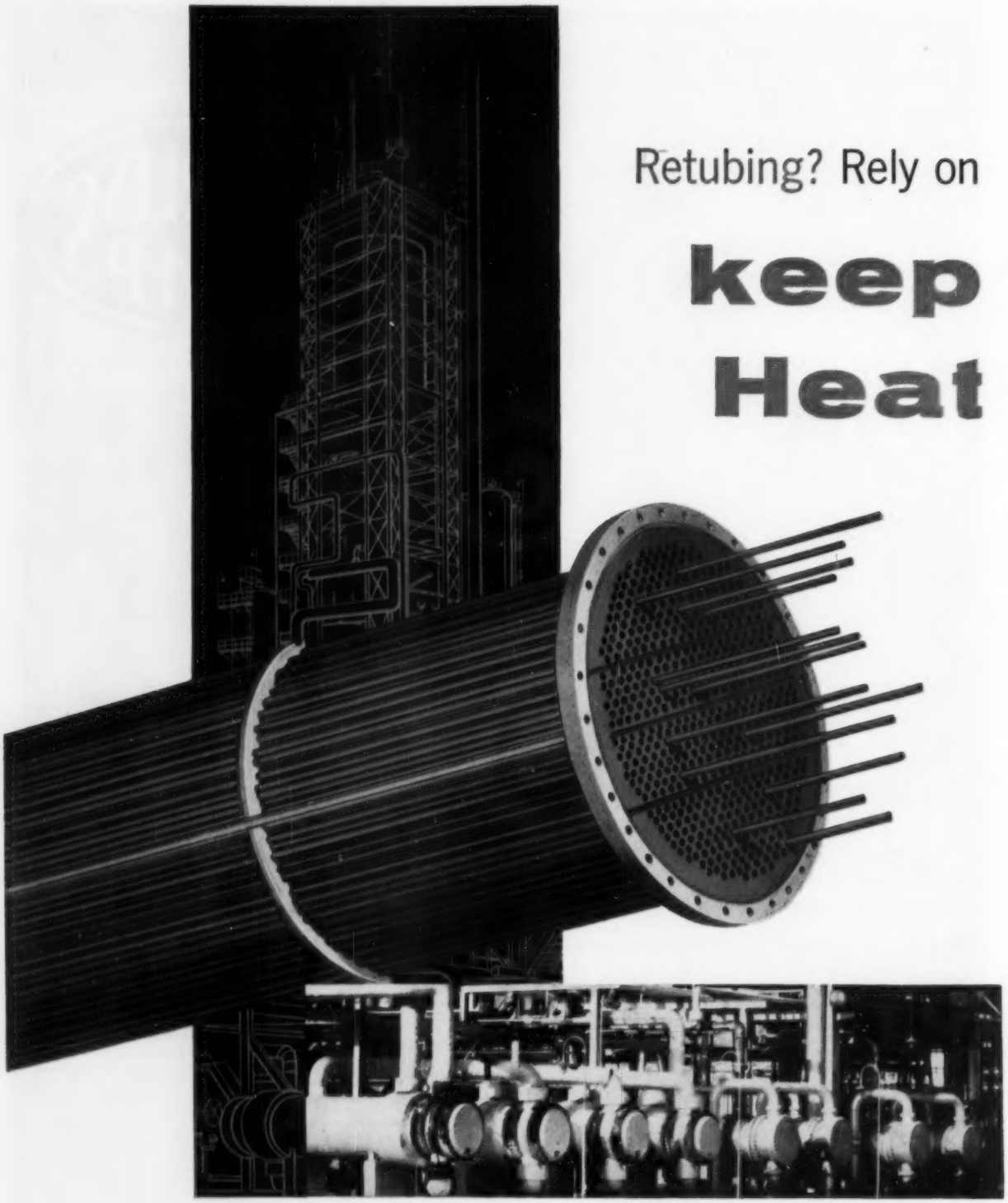
TOWN _____ STATE _____

Pet. Refiner

For more data on advertised products, use Readers' Service Cards, last page.

Retubing? Rely on

keep Heat



First for Lasting Quality—from Mine to Market!

Phelps Dodge COPPER-BASE ALLOY Tubes to

your Exchangers On-Stream!

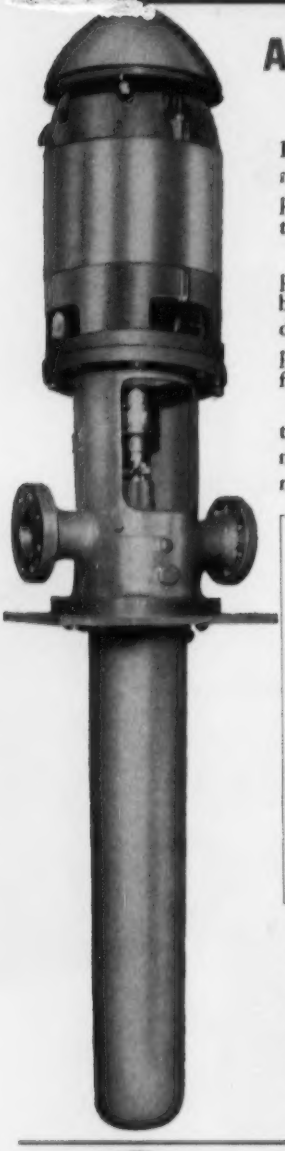
- ✓ **Complete line of copper-base alloys** including Bi-Metal combinations to meet special corrosive conditions.
- ✓ **Speedy delivery** from strategically-located warehouses.
- ✓ **Careful analysis of your corrosion problems** by experienced engineering staff.
- ✓ **Quality-controlled fabrication** to assure finest tube properties.
- ✓ **Information and sales service** available from nearest Phelps Dodge district office.*

PHELPS DODGE COPPER PRODUCTS CORPORATION

*SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle Washington, D. C.

For more data on advertised products, use Readers' Service Cards, last page.

NEW! Bingham VCP VERTICAL PUMP FOR LOW NPSH



ALL WORKING PARTS ACCESSIBLE WITH BOTTOM DISMANTLING

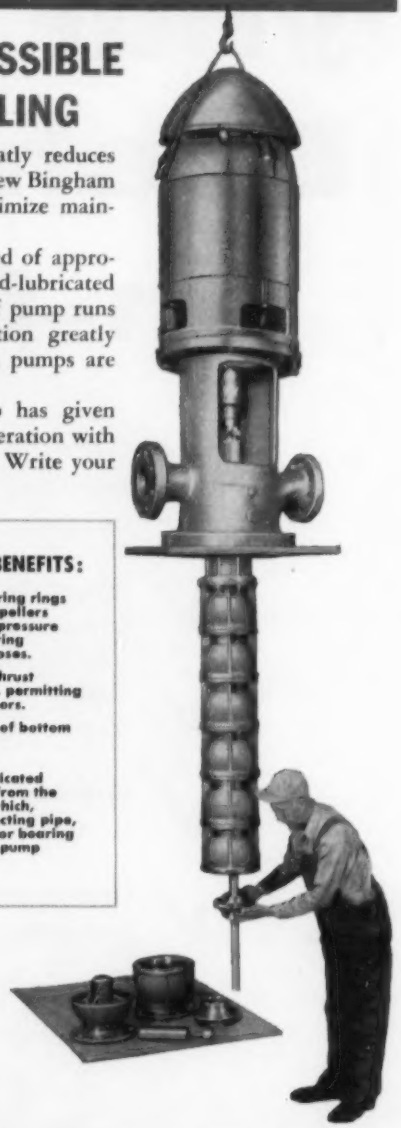
Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced features which minimize maintenance, reducing need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by pumpage. Bottom bearing is lubricated, even if pump runs dry for short periods. This *dependable* lubrication greatly prolongs life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever installed, the Bingham VCP Pump has given trouble-free service — plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.

ONLY Bingham OFFERS ALL THESE BENEFITS:

1. Heavy-duty steel suction and discharge head rigidly built to eliminate vibration caused by drivers.
2. Shaft is maximum diameter throughout.
3. Shafts are equipped with renewable 11-13 chrome, hardened, ground and polished sleeves at each bearing.
4. Bearings are of the appropriate material for the different pumpages.
5. Maximum head per stage and maximum efficiency for a given capacity range.
6. Front and back wearing rings on enclosed type impellers permit a one-stage pressure drop over each bearing for lubrication purposes.
7. Wear rings reduce thrust of rotating element, permitting use of standard motors.
8. Maximum eye area of bottom impeller for lowest possible NPSH.
9. Bottom bearing lubricated by pumpage taken from the discharge column, which, together with connecting pipe, acts as a reservoir for bearing lubrication in event pump operates "dry" for short periods.



All working parts of pump easily accessible with bottom dismantling. One man can service after lifting pump from well. By dismantling from bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from top, necessitating removal of driver and head before pump unit is accessible).

Various operators estimate that time required to reach working parts has been reduced as much as 50%.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

***General Offices:* 2800 N.W. Front Avenue, Portland 10, Oregon**

***Factories:* Portland, Ore. • Vancouver, B.C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.
CHICAGO, ILL.
DENVER, COLO.
HOUSTON, TEXAS
KANSAS CITY, MO.
NEW ORLEANS, LA.
NEW YORK CITY, N.Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B.C., CAN.

For more data on advertised products, use Readers' Service Cards, last page.

The WEDGEPLUG Principle Assures Dependable Performance at High Temperatures and Pressures . . .

NON LUBRICATED

LIFTS – TURNS AND RESEATS IN ONE OPERATION

Wedgeplug Steel Valves are scientifically designed so that no lubricant is needed to free the plug from the body seats, or to seal the plug from leaking after operation. Can be supplied: wrench-operated; handwheel-operated; and worm gear-operated. Adaptable for remote control thru use of electric, air-motor, or air-cylinder operator.

WEDGEPLUG
NON-LUBRICATED
STEEL PLUG VALVES

Write for Wedgeplug Catalog No. 54-1-W

WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS 25, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

DESIGN ELIMINATES NEED FOR LUBRICATION

For more data on advertised products, use Readers' Service Cards, last page.

WHEN YOU'RE UNDER PRESSURE

ON PRESSURE VESSELS . . .

THIS IS THE KIND OF HELP YOU GET AT KELLOGG . . .

Design Engineering: Kellogg will assume entire responsibility or work closely with your own design engineers on their proposals. Optimum designs are assured either way.

Technical Competence: Kellogg's experience in metallurgy, heat transfer, stress analysis, metal fatigue, corrosion control, is unequalled among pressure vessel fabricators.

Fabricating Techniques: Kellogg fabrication methods are the culmination of 40 years of building pressure vessels to exacting specifications. Many improved techniques have resulted, such as K-Weld*.

Non-Destructive Testing: Kellogg's complete facilities include the company's portable "atomic cameras" which can photograph welded seams up to six inches thick in a single short exposure.

Prompt Delivery: Kellogg's plant modernization program assures faster delivery than ever before. Small and large orders receive the same attention.

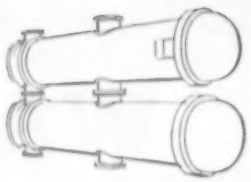
Construction Service: Kellogg's continuing work in erecting vessels for complete oil refineries, pulp mills, and chemical plants provides a fully-staffed construction department with crews that know their jobs.

Guaranteed Performance: Kellogg's reputation has been built on long and efficient product life. The MWK name plate is your guarantee.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.
In Canada: The Canadian Kellogg Company, Limited, Toronto
In Europe: Kellogg International Corporation, London
SUBSIDIARIES OF PULLMAN INCORPORATED

*Trademark of The M. W. Kellogg Company

PUT YOUR PROBLEMS UP TO M KELLOGG W

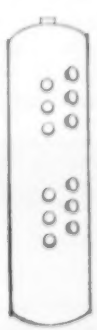


HEAT TRANSFER EQUIPMENT

TANKS AND REACTORS

KNOCKDOWN VESSELS

PROCESS PIPING



PRESSURE VESSELS

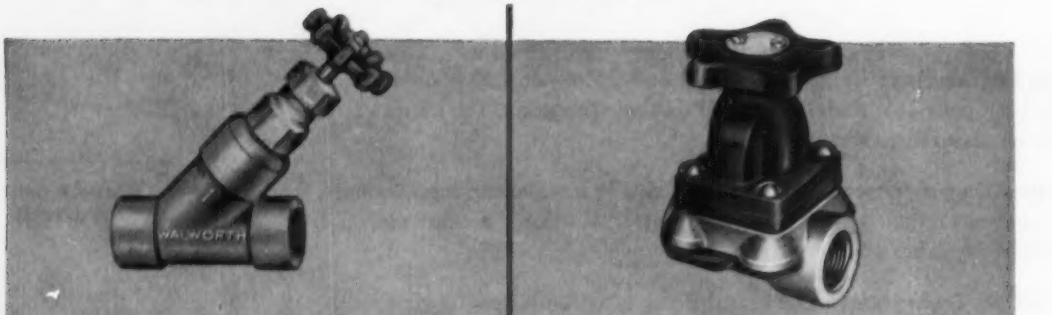
For more data on advertised products, use Readers' Service Cards, last page.

Iron... Steel... Bronze...

Special Alloys **and now...** *PLASTICS!*

WALWORTH PVC

globe and diaphragm valves



pipe and fittings

CORROSION-RESISTANT TO GIVE YOU NEW AND LASTING PROTECTION!

Walworth rigid plastic polyvinyl chloride valves, *and* fittings provide safe, trouble-free lines to handle wet and dry hydrogen gas—sulphur dioxide—dilute nitric acid—sulphuric acid—natural gas—sugar juice—milk—vinegar—tanning solutions and literally scores of other corrosive as well as noncorrosive materials in the chemical, petroleum, pulp, paper, food and other industries.

Walworth polyvinyl chloride valves *and* fittings are molded to the *same* rigid Walworth specifications by the *same* molder—the General American Transportation Corporation—of the *same* basic material,—Geon rigid vinyl from B. F. Goodrich Chemical. Rigid plastic pipe of the same materials and made by the same molder is also available. Consistent performance is therefore assured throughout *all*-Walworth PVC piping systems. Plastic valves, fittings, and pipe offer the following advantages:

1. **Exceptionally resistant to most salts, alkalis, and nonoxidizing acids at temperatures below 150° F.**
2. **High burst strength and impact resistance.**
3. **Nontoxic, and extreme low flammability.**
4. **Easy to install.**

Get the complete Walworth PVC product story. Write for brochure containing detailed specifications, characteristics, and application data.

WALWORTH

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

WALWORTH COMPANY OF CANADA, LTD.

Toronto • Calgary

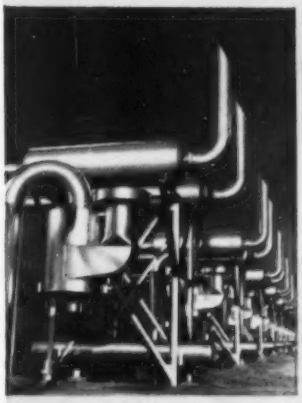
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Here's how America's oil industry uses aluminum paint

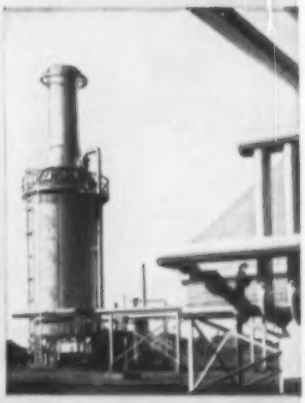
For tanks. Sinclair Refining Company has used aluminum paint since 1916 for coating bulk stations, terminals, tank farms and refinery equipment like this installation at Marcus Hook, Pa. Because Sinclair Aluminum Paint is outstanding in the protection of metal, reducing evaporation losses and improving appearance it is the standard protective coating for Sinclair's refineries throughout the country. *Aluminum Paint: Sinclair Refining Co., Paint Department, New York.*

For rigs, oil field equipment. The Parkersburg Rig and Reel Company, Parkersburg, W. Va., has painted its rigs, lease tanks and other equipment with aluminum paint since 1925. This company finds that aluminum paint provides better protection against rust, lasts longer, makes a more attractive appearance, is easier touched up without looking "patched up."

For towers. Magnolia Petroleum Corporation paints towers like these at the Chitwood Gasoline Plant with aluminum. Magnolia finds that aluminum paint improves appearance, is easy to apply and has excellent qualities of durability. *Aluminum paint: Socony Paint Products, Inc., New York.*



For mufflers. These 400°-600° F mufflers at Cotton Valley Operators Committee, Recycling Plant, Cotton Valley, Louisiana, were constantly rusting and peeling, requiring frequent repainting. High-heat aluminum paint was tried, and is now the standard heat-resistant finish for this plant. *Aluminum paint: Silicone Aluminum, Kansas Paint & Color Company, Wichita, Kansas.*



For heater stacks. Warren Petroleum Corporation reports that aluminum paint has an effective service life of 18 months or more on oil heater stacks where surface temperatures range from 400°-600° continuously. Previously used paints had lasted only a few days. Now, high-heat aluminum paint by Kansas Paint & Color Co. is a standard at all Warren plants.

Leading refineries rely on aluminum paint for maximum protection, long service life, unsurpassed economy. Examples such as these demonstrate why aluminum paint has become the most popular, most practical paint in the petroleum industry. **ALCOA does not make paint,** but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by your paint manufacturer to solve individual problems. Paints made to these formulas actually cost less, last longer, give utmost protection against heat, cold, sun, rain, smoke, fumes.

Write today for our FREE booklets, *Painting With Aluminum* and *Aluminum Asphalt Roof Coatings Make Time Stand Still.* They contain valuable, up-to-date information on all types of aluminum paint and aluminum roof coatings. Use the coupon.

PIGMENTED WITH
ALCOA
ALUMINUM
ALUMINUM COMPANY OF AMERICA

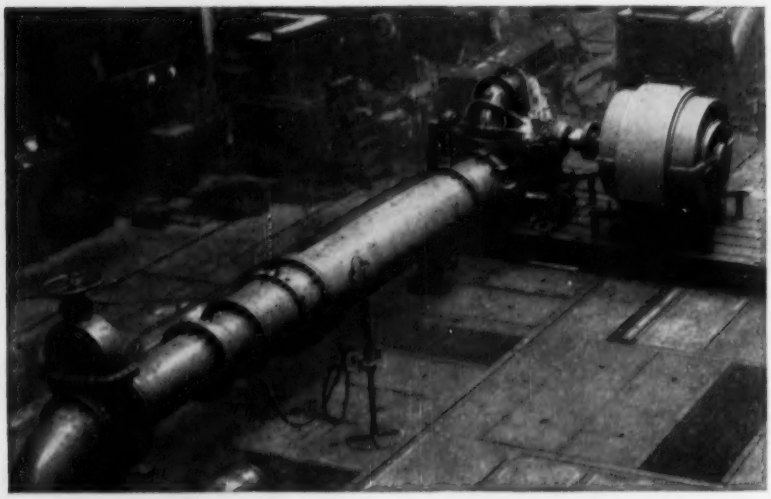
Aluminum Company of America, Paint Service Bureau
1793-K Alcoa Building, Pittsburgh 19, Pennsylvania
Please send me your FREE booklets:
☐ Painting With Aluminum
☐ Aluminum Asphalt Roof Coatings Make Time Stand Still

Name_____
Company_____
Address_____
City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

Keep your eye on WORTHINGTON

Pump research primes pump progress



TEST STAND CAPACITY UP TO 100,000 GPM is provided at Worthington's Harrison plant *(above)*. Built over a man-made half-acre lake, the test stand is used as a production tool to check pumps from fractional horsepower up. This flexibility comes in handy—in one line alone Worthington can put together 60,000 different standard pumps out of 650 parts in six standardized sets of liquid ends.

DIRECTING PUMP TEST OPERATIONS from central control room *(left)* where special measuring instruments speed collection of performance data. Worthington pump specialists can afford to be objective in considering your pump application problem. They select from the most complete line of pumps offered by any manufacturer.

We have a lot of experience at Worthington—more than 114 years of it—and we're picking up more all the time.

But technology advances every day. Each step forward brings with it new and unsolved pumping problems. That's why Worthington's research and development program is continuous. That's also why we like to work with you during planning to get the jump on problems before they reach the costly stage.

Experts for every problem

For your day-to-day pumping problems, our sales engineers are thoroughly trained in pump applications in every field, and can usually supply the right answer fast. Naturally, for the really tough ones, our staff engineers back them up with all the equipment and facilities of our shops and laboratory. In addition, factory-trained troubleshooters are available to cope with any problem that may arise in the field.

From cat-cracker to atom-cracker

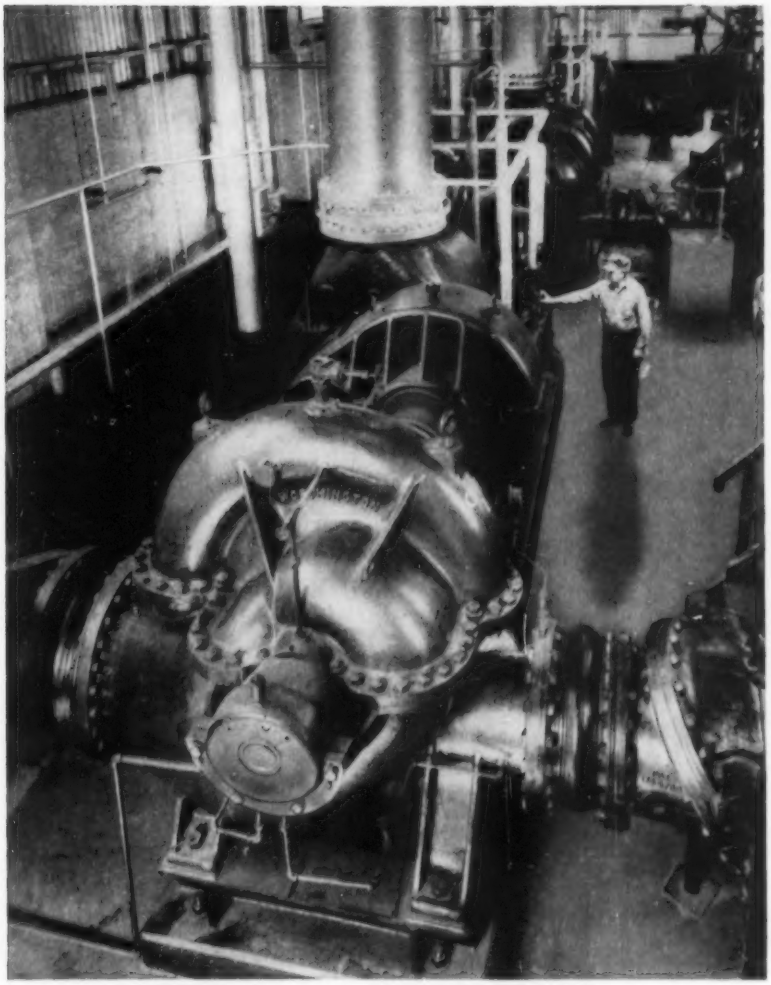
Our specialists, covering all major industries, work as a team. Together, they bring to bear on any problem a vast store of experience. They've successfully solved pumping problems and helped pioneer new developments in public works, atomic energy applications, the oil industry, and the chemical industry—to name a few.

So keep your eye on Worthington; we probably have a money-saving answer to your pumping problems. C.5.1

WORLD'S FIRST ATOMIC-POWERED SUBMARINE, *NAUTILUS*, undergoing sea trials. In atomic development since 1941, Worthington recently built special engine room equipment for both atomic submarines, *Nautilus* and *Sea Wolf*. Worthington continues to figure prominently in supplying this new field of atomic energy, keeping pace with its new and rapidly changing requirements.

EUTECTIC CASTING, used in making standard Worthington pumps, frees engineer from casting restrictions. Formerly, design of impeller and diffuser blades had to allow hand withdrawal from fragile sand core. Eutectic casting uses a low-melting-point alloy to form blades, melting this alloy out during baking. This permits design flexibility for maximum hydraulic performance.

VITALITY OF WORTHINGTON RESEARCH PROGRAM is shown by the more than 300 articles in the technical press during the past five years by Worthington people. This flood of informative technical literature not only reflects our ability to keep pace with the changing hydraulic requirements for modern pumps, but also highlights the important contributions by Worthington to the knowledge of pumps.



Three Worthington horizontal centrifugal pumps at Gulf Coast refinery.

Gulf Coast refinery picks Worthington horizontal centrifugal water pumps

In oil refining operations you've got two strikes against you if you can't count on a dependable general water supply.

You need water for cooling towers, general service, engine and compressor cooling, heat exchangers and condensers. And water must be available 24 hours a day to eliminate costly down-time.

That's why a Gulf Coast oil company picked three Worthington turbine-driven horizontal centrifugal pumps *(above)* for water in their Texas refinery. These units operate continuously at rated capacity, head and efficiency.

The easy accessibility for inspection and maintenance, the 24-hour dependability and sustained performance of these pumps reflect Worthington's experience with refinery pumping problems.

Why a horizontal pump?

Here are five big reasons for installing a Worthington horizontal centrifugal pump:

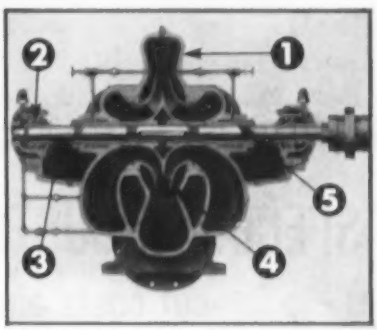
1. Casing – horizontally split. Upper half lifts off to allow inspection and maintenance.

2. Bearings – double-row ball bearings are easily accessible for servicing and replacement. Location prevents contamination from water being pumped.

3. Shaft – easily arranged for dual drive. Shaft may be extended opposite main drive source to accommodate any standby prime mover.

4. Symmetrical impeller – balanced axial forces mean negligible thrust loads for low wear, long life. High initial and sustained efficiency.

5. Stuffing boxes – under suction pressure and fitted with renewable shaft sleeves.



Horizontal centrifugal pump (cutaway view).

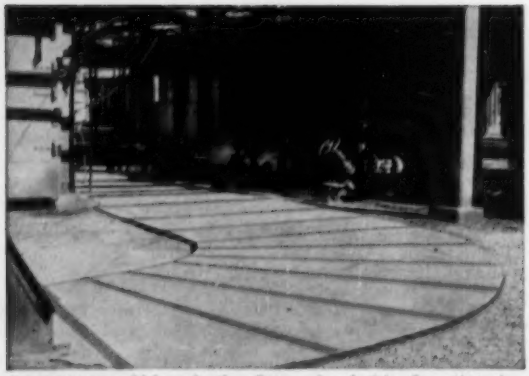
There's a Worthington horizontal centrifugal pump for every purpose. Available with casing, impeller, shaft, shaft sleeve, and wearing rings in bronze, iron or alloys for various water conditions — with standard water-sealed stuffing boxes or mechanical seals. Get all the facts on Worthington horizontal centrifugal pumps for your application — jot down your requirements on your letterhead and we'll send you bulletins on suitable pumps promptly. Write Worthington Corporation, Section C.5.1C, Harrison, N.J.

C.5.1C

WORTHINGTON

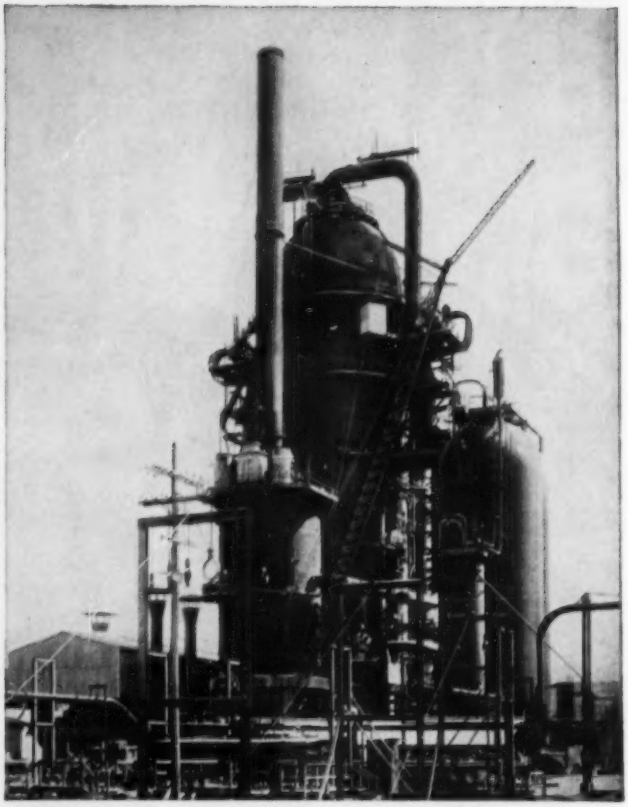
THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

CENTRIFUGAL • ROTARY • STEAM • POWER • VERTICAL TURBINE



ADAPTABLE – Although the flat arch of this flue (interior shown below) curves alongside the coke still, construction was fast and simple with Lumnite-made industrial concrete.

TROUBLE-FREE SERVICE – Interior of heat-resistant flue is in excellent condition after ten years of service at 1000° F.



LONGER-LASTING LININGS–This Kellogg Orthoflow fluid catalytic cracking unit is lined with a Lumnite-made refractory insulating concrete.

SPECIAL INDUSTRIAL CONCRETES made with LUMNITE*

cut costs and improve efficiency throughout the plant

If you have a heat, corrosion or insulation problem at your refinery, chances are that Lumnite calcium-aluminate cement can help solve it. That's because special industrial concretes made with Lumnite cement are actually three-in-one concretes. They not only resist heat and corrosion, *they insulate at the same time.*

Versatile industrial concretes made with Lumnite cement are quickly placed – by cement gun, troweling or pouring – and they reach service strength within 24 hours! Downtime is reduced, labor costs are cut, and production losses are kept to a minimum.

For added convenience, you can use prepared castables (packaged mixes of Lumnite cement and aggregates selected for specific temperature and insulation requirements – add only water). They're made and distributed by leading manufacturers of refractories. For more information, write Lumnite Bureau, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, New York.

USE SPECIAL INDUSTRIAL CONCRETES FOR

1. **REFRACTORY INSULATING CONCRETE** – in strippers, rerun chambers, reactors, regenerators, fractional distillation and thermal alkylation units.
2. **ABRASION-RESISTANT REFRACTORY CONCRETE** – Catalyst transfer and discharge lines, reforming chambers, gas coolers, reactor cyclones and transfer lines, regenerator cyclones and return lines.
3. **REFRACTORY CONCRETE** – in bubble and flash towers, continuous-pressure stills.
4. **CORROSION-RESISTANT AND REFRACTORY INSULATING CONCRETE** – linings in regenerator exhaust lines, stacks, ducts.
5. **CORROSION-RESISTANT CONCRETE**–in linings for sweetening and storage tanks, waste-disposal systems, and trenches.

OFFICES: *Albany, Birmingham, Boston, Chicago, Dayton, Kansas City, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, Waco.*

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PR-L-101

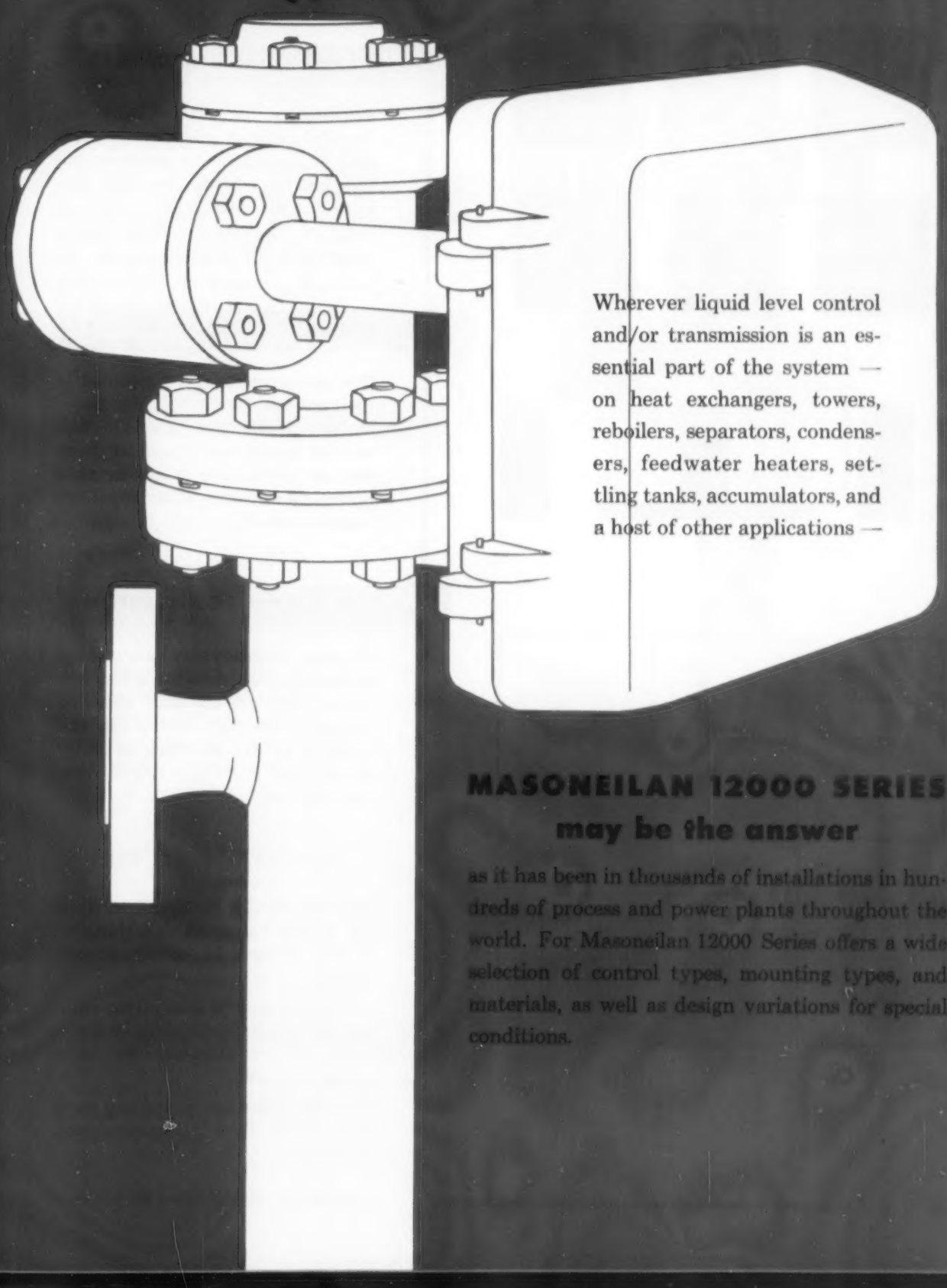
ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR – Televised alternate weeks – See your newspaper for time and station.

Name *Your* Level Problem

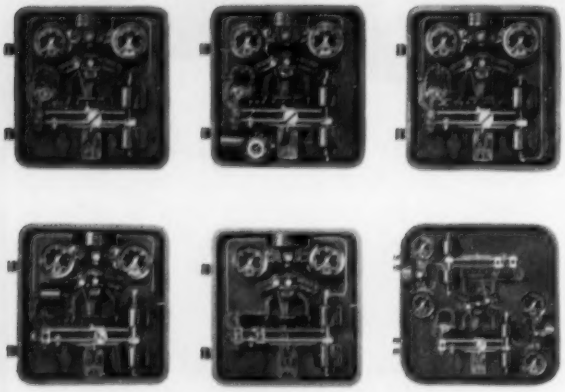


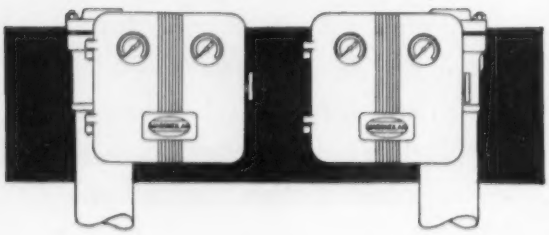
Wherever liquid level control and/or transmission is an essential part of the system — on heat exchangers, towers, reboilers, separators, condensers, feedwater heaters, settling tanks, accumulators, and a host of other applications —

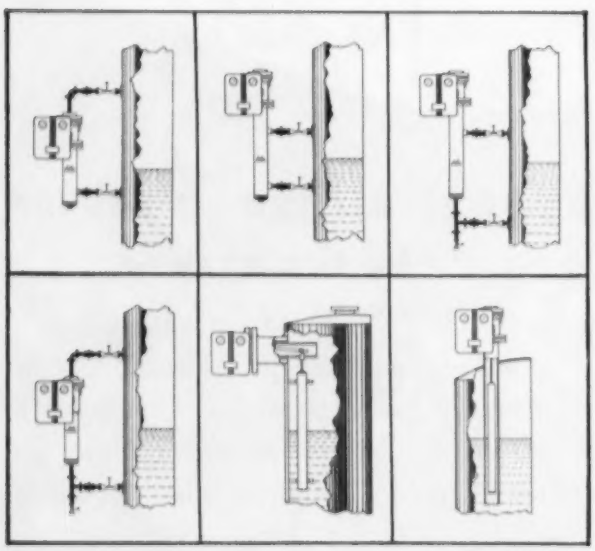
MASONEILAN 12000 SERIES may be the answer

as it has been in thousands of installations in hundreds of process and power plants throughout the world. For Masoneilan 12000 Series offers a wide selection of control types, mounting types, and materials, as well as design variations for special conditions.

There's a Masoneilan Level Controller







TYPES OF INSTRUMENTS

Proportional, proportional-reset, differential gap and pneumatic set controllers; pneumatic transmitters; duplex instruments with required combinations of these types — all are standard models. Standard output ranges 3-15 or 6-30 psi.

INSTRUMENT MOUNTINGS

The instrument may be mounted to right or left of the displacer chamber — and may readily be changed in the field without special tools. Displacer chambers are available with mid-flange, if desired for field orientation; or with integral construction.

MOUNTING CONNECTIONS

Displacer chambers may have screwed or flanged connections located at top-and-bottom; top-and-side; side-and-bottom; or side only. Internal displacer types for flanged mounting on top or side of vessel provide for special vessel requirements.

MATERIAL SELECTION

Displacers may be Type 304, Type 316 stainless steel; Monel; Hastelloy B or C; Durimet 20; copper; or solid Teflon.

Chambers may be iron; carbon steel; carbon moly; chrome moly; stainless steel; Monel; or other castable and/or weldable alloys.

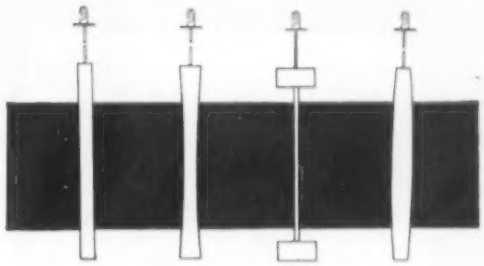
Torque Tubes may be Inconel; phosphor bronze; Type 316 stainless steel; or Monel.

For more data on advertised products, use Readers' Service Cards, last page.

for Practically every Application

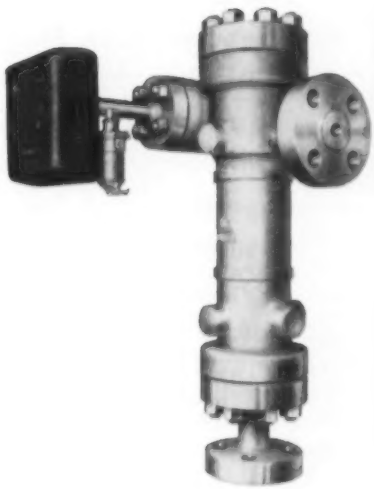
TYPES OF DISPLACERS

Standard displacers are cylindrical, having a constant volume regardless of level range. The shape may be varied for special applications provided that volume remains within design limits of the instrument. Step-type displacers with two or more steps may be useful for alarm or similar service.



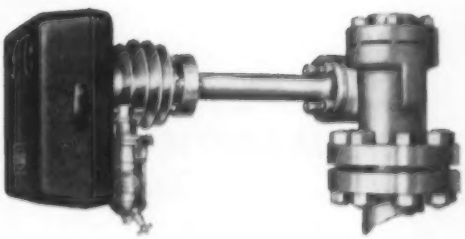
HIGH OR LOW PRESSURE

Ratings available range from Class 125 iron to 2500 lb ASA steel — depending on mounting type.



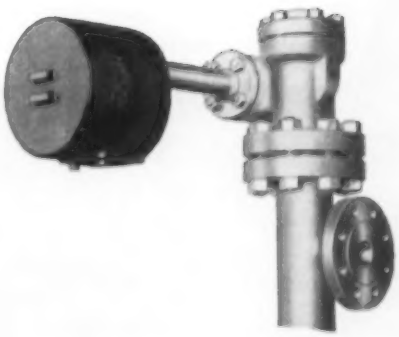
HIGH OR LOW TEMPERATURE

Air-fin torque tube housing extensions available for high temperature; displacer chamber extensions for low temperature. Operating ranges between minus 400°F and plus 850°F.



LEVEL RANGES

Standard ranges are 14″, 32″, 48″, 60″, 72″, 84″, 96″, 108″ and 120″; special ranges available.



ELECTRONIC TRANSMITTERS

A suitable electronic transmitter may be substituted for the standard instrument if desired.

For more data on advertised products, use Readers' Service Cards, last page.

Look at the Whole Picture

ALL HIGH Quality Efficient PRODUCTS

One well-designed and manufactured part does not make a level controller that will provide accurate performance over a long period with a minimum of maintenance and operation delays. *Every* part must be designed and manufactured so that all combine to make a controller which incorporates wise selection of materials for the intended service; skillful design for accurate operation; and experience which forestalls the difficulties you are likely to encounter in the field.

So in selecting level controllers and transmitters, evaluate *all* the quality factors — and compare.

Take the first step by writing for complete data on Masoneilan 12000 Series.

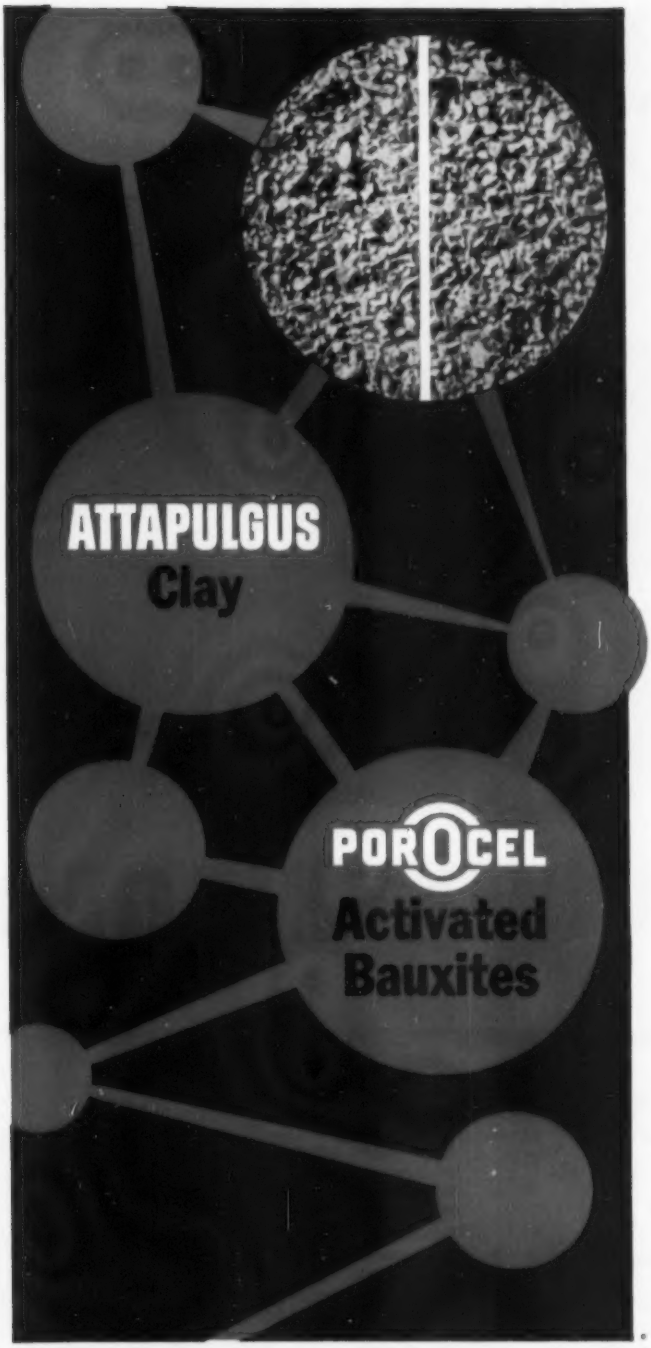
MASONEILAN

MASON-NEILAN REGULATOR CO.

1182 ADAMS STREET, BOSTON 24, MASS., U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse Chicago • St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta Cleveland • Cincinnati • Detroit • San Francisco • Boise • Louisville • Salt Lake City • El Paso • Albuquerque • Odessa • Charlotte • Los Angeles Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Dallas Seattle. Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

For more data on advertised products, use Readers' Service Cards, last page.



Here's the way to tackle a sorptive-mineral job

Away up in number two slot in a list of nearly 2,000 different chemicals used in petroleum refining operations is *sorptive minerals*. And the adsorbents recognized as standards in the industry are Minerals & Chemicals products—Attapulgus Clay . . . Porocel Activated Bauxites. That means there's a *headquarters* to turn to!

Want To Purify By Adsorption? There's an M&C adsorbent to fit your process scheme for removing odors, colors, taste, moisture, acids, sulfur compounds, fluorides and unsaturates from process liquids or gases.

Catalyst Carrier? M&C sorptive minerals are of highest importance in a wide variety of hydrocarbon conversion and sweetening processes.

What Do You Want To Dry? M&C offers a complete line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases.

HERE'S THE NEWEST APPLICATION *of sorptive minerals in the petroleum field. Mail the coupon for your free copy of "Preparation of Petroleum Feeds for Platinum Catalysts"—and for other assistance if desired.*

ATTAPULGUS *and* **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
210 W. WASHINGTON SQUARE, PHILADELPHIA 5, PA.

ALWAYS A BETTER WAY . . .

MINERALS & CHEMICALS CORPORATION OF AMERICA
Dept. D, 210 W. Washington Square, Philadelphia 5, Pa.

☐ Please send me "Preparation of Petroleum Feeds For Platinum Catalysts."

☐ Please provide technical help (and samples) on the following proposed applications: _____

_____

name _____ title _____

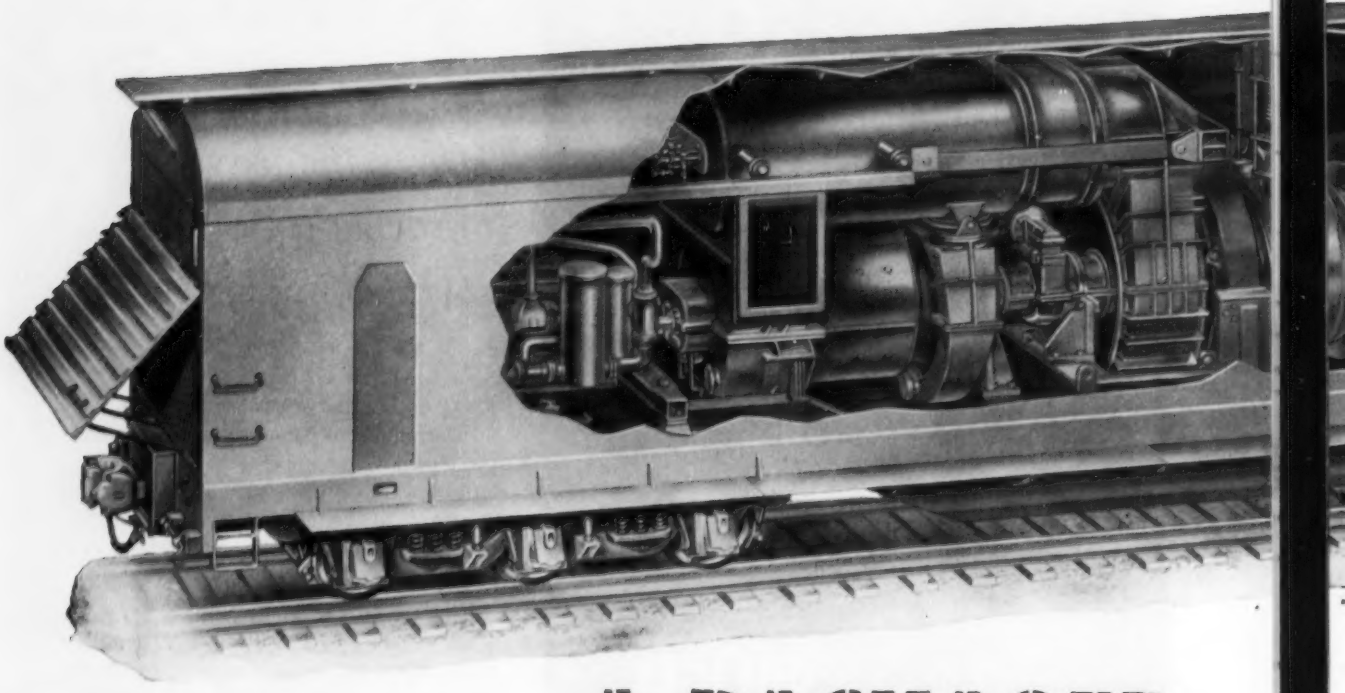
company _____

address _____

city _____ zone _____ state _____

For more data on advertised products, use Readers' Service Cards, last page.

Revolutionary Clark development in mobile power generation



A PACKAGED

KEY FEATURES

1 **COMPLETELY SELF-CONTAINED**
Requires only connection to fuel source and electrical load.
No water nor outside power needed.

2 **ONE-MAN OPERATION**
Simple, pneumatic controls. Complete, built-in, dead front switchgear.

3 **MOVED AT HIGH SPEEDS**
Can be hauled on regular passenger or freight train service. All components specifically designed for mobile operation. Special, heavy duty car.

4 **QUICKLY PLACED IN SERVICE**
No site preparation required. Operates on any reasonably level track.

5 **3-POINT SUPPORT**
Car flexing does not affect alignment of power unit.

6 **DUAL FUEL OPERATION**
Burns wide range of liquid or gaseous fuels simultaneously or individually.

7 **SPLIT SHAFT DESIGN**
No alignment problem. No step-down gears between turbine and load. No physical connection between turbines.

8 **THERMO-ELASTIC DESIGN**
Hot parts expand without stress. No bearing misalignment.

9 **LONG LIFE — LOW TEMPERATURE**
Minimum blade life of 100,000 hours.

10 **AIR COOLED — NO WATER REQUIRED**

11 **DUAL MULTI-STAGE HIGH AND LOW PRESSURE TURBINES**

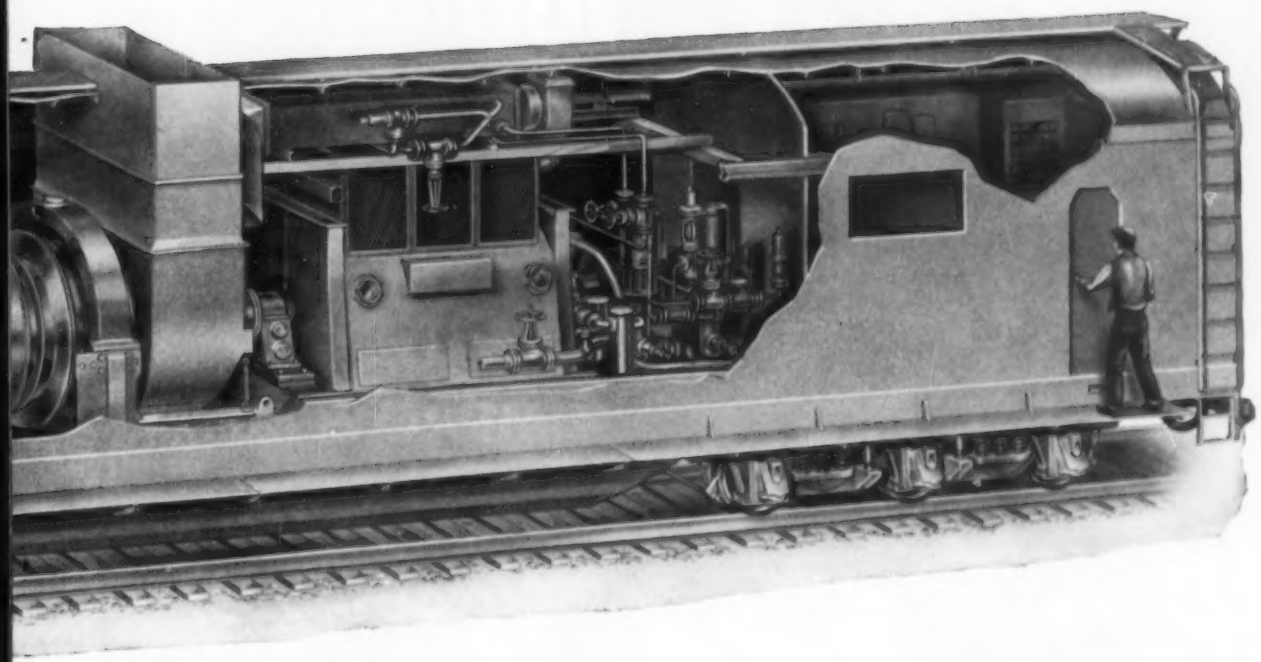
12 **LIFETIME SINGLE COMBUSTION CHAMBER**

13 **MINIMUM RADIATION**
All exposed surfaces cool enough to touch.

14 **FLEXIBLE ELECTRICAL CHARACTERISTICS**
Dual frequency. Operates in parallel with existing facilities or independently.

15 **UNUSUAL ACCESSIBILITY**
All parts readily accessible for rapid inspection and servicing.

For more data on advertised products, use Readers' Service Cards, last page.



5500 KW POWER PLANT

Completely self-contained in a single R.R. car

The Navy ordered it. Clark built it — a packaged 5500 KW mobile power plant completely self-contained in a single railroad car, for emergency use by the Bureau of Yards & Docks.

Featuring a completely new, Clark designed combustion gas turbine, driving a synchronous generator, the unit is specifically designed as a mobile emergency power station to supply a substantial block of power on short notice. Clearly, this is a development that offers many opportunities to the armed forces, civil defense, public utilities and industry

Furthermore, the unique gas turbine which drives the generator is extremely well suited as a matching driver for centrifugal compressors serving the gas transmission, refining, process and other industries.

Clark engineers will gladly furnish details and discuss specific applications with you. Complete brochure mailed on request.

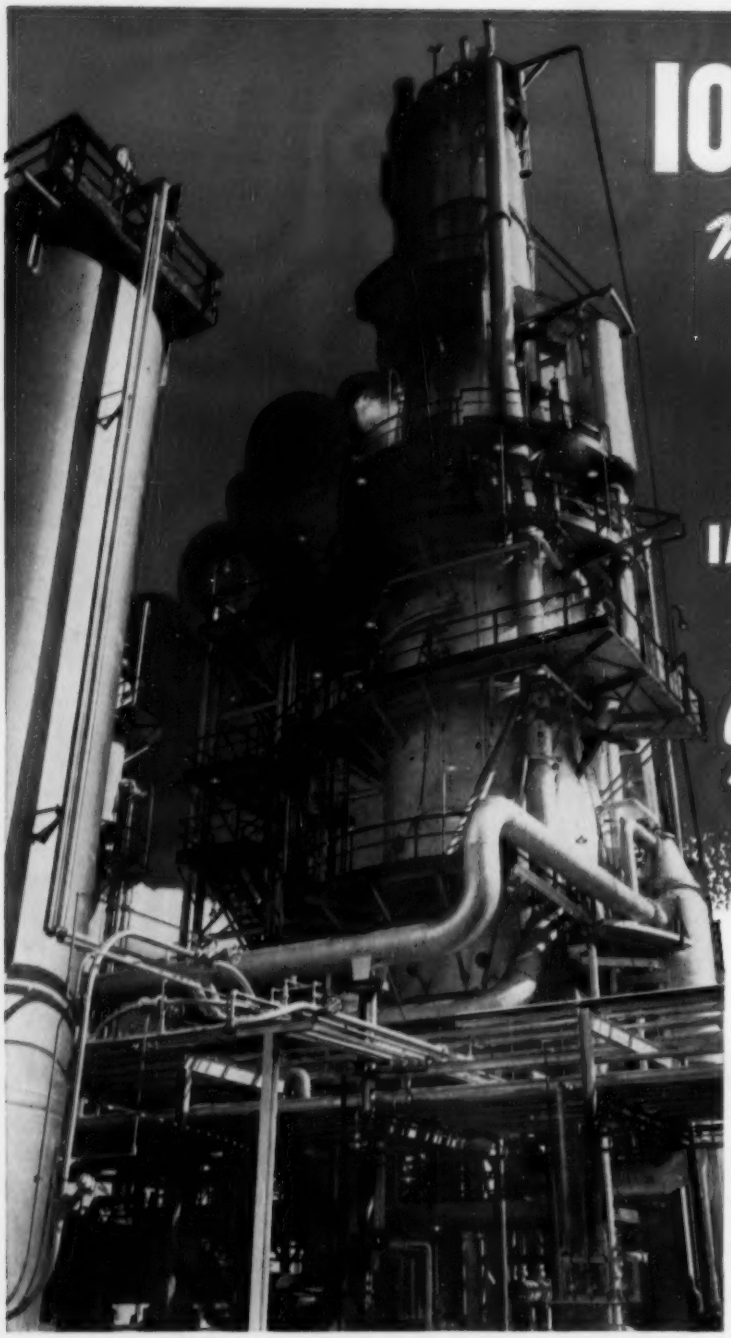
CLARK BROS. CO. • OLEAN, N. Y.

Offices in Principal Cities throughout the World

CLARK — ONE OF THE DRESSER INDUSTRIES

TURBINES
ENGINES
COMPRESSORS

For more data on advertised products, use Readers' Service Cards, last page.



100 octane +

Meet the Challenge of Competition With

QUALITY IMPROVEMENT

of YOUR gasoline!

The demand for higher octane gasoline is increasing rapidly and it is only a matter of time until you will be faced with meeting the challenge of 100 octane (plus) gasoline. Our prediction is that it will be earlier than you think.

Treco would like to help you, too! Get started now, in advance of competition. Call us to discuss your requirements. Remember . . . Treco designs, engineers and constructs — f a s t.

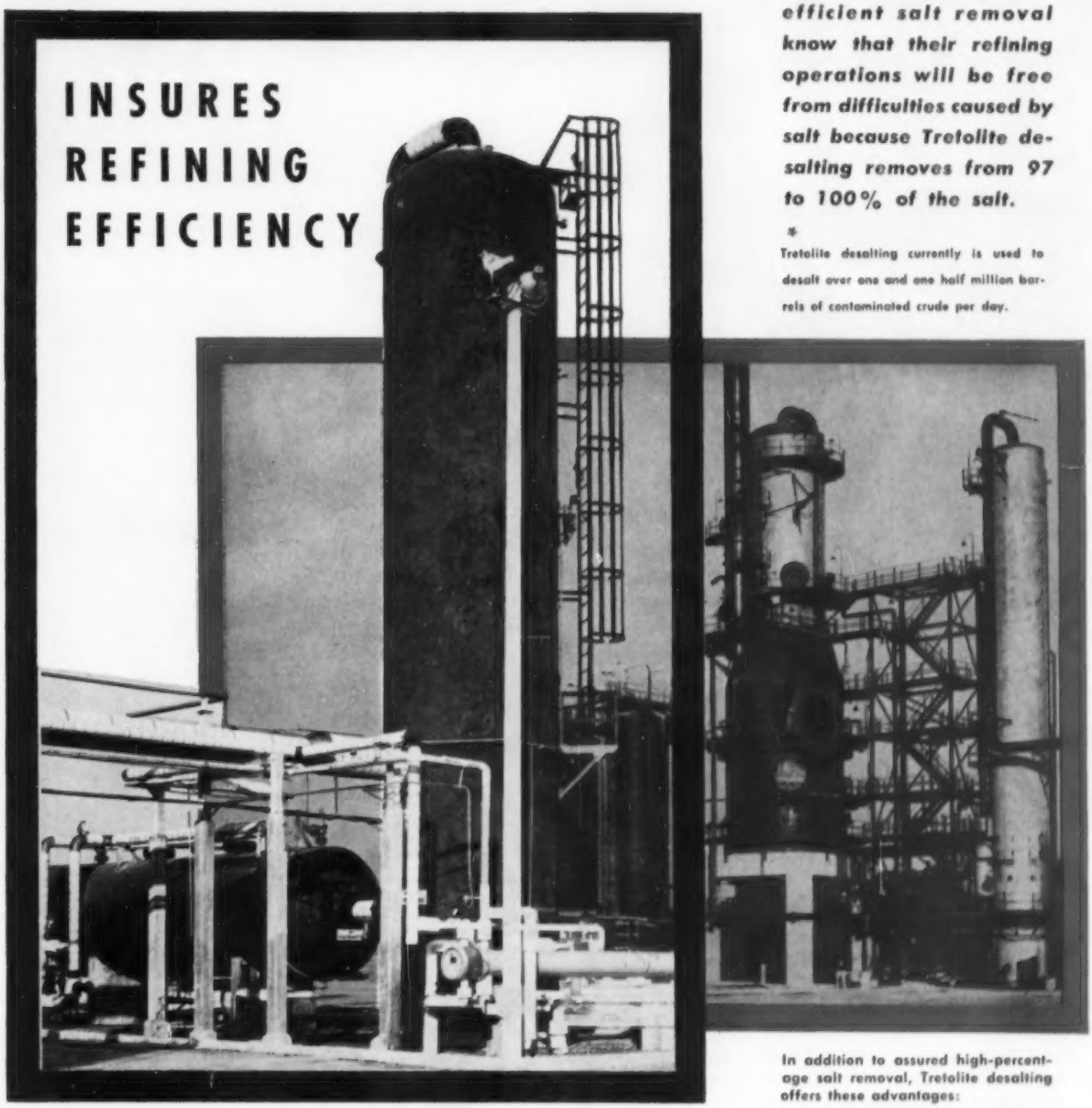
TRECO

REFINERY ENGINEERING *Company*

TULSA **TORONTO**

TRETOLITE DESALTING

INSURES REFINING EFFICIENCY



The many * refiners who depend on Tretolite for efficient salt removal know that their refining operations will be free from difficulties caused by salt because Tretolite desalting removes from 97 to 100% of the salt.

* Tretolite desalting currently is used to desalt over one and one half million barrels of contaminated crude per day.

As an additional insurance against lost refining efficiency caused by corrosion damage, ask your Tretolite Refinery Engineer about Kontol Corrosion Preventives. They are effective, economical, and proved.

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri • 5515 Telegraph Road, Los Angeles 22, California

Specialized Chemicals and Services for the Petroleum Industry

DEMULSIFYING • DESALTING • WATER DE-OILING
CORROSION INHIBITING • PARAFFIN REMOVAL • SCALE PREVENTION • PRODUCTION STIMULATION

In addition to assured high-percentage salt removal, Tretolite desalting offers these advantages:

1. *The low treating cost per barrel results in economical operations.*
2. *The simplicity of the process assures a low installation cost.*
3. *Flexibility of operation permits the desalting of various crudes with varying salt contents.*
4. *Emulsion resolution is thorough, resulting in a clean water effluent.*
5. *Solids such as sand, silt and drilling mud are effectively removed, preventing plugging and erosion.*
6. *Catalyst poisons such as arsenic and trace metals are substantially reduced, preventing catalyst contamination.*

TR 5528

to regulate and record—

TEMPERATURE.. PRESSURE.. VACUUM..TIME

mechanical instruments by

WESTON

RECORDING INSTRUMENTS . . . in 9", 10" and 12" chart sizes — single and multipen — for all requirements.

RECORDING CONTROLLERS . . . handle temperatures from −325°F to 1000°F—vacuum to 30" mercury — pressures to 7500 psi or higher.

TIME CONTROLLERS . . . make any semiautomatic retort control system fully automatic. Available in both standard and special forms.

INDICATING CONTROLLERS . . . accurately regulate temperature, vacuum, pressure and indicate on direct-reading scale.

DIAL THERMOMETERS (remote reading) . . . furnished with mercury, gas, or vapor pressure actuations. Flush or wall mounting. Indicate low as −325°F., high as 1000°F.

Just Published!

Just published . . . the new catalog M2A which fully illustrates and describes the comprehensive line of WESTON mechanical instruments, noted for their long-time accuracy and dependability. Send for your copy today; or ask your local Weston representative for help on any measurement or control problem involving temperature, vacuum, pressure. Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey, *a subsidiary of Daystrom Incorporated.*

WESTON *Instruments*

Leak Proof

Sooner or later, ordinary valves leak because they depend solely upon uncertain metal - to - metal seating. Rockwell - Nordstrom valves are leak proof because the unique Sealdport* lubrication system surrounds the plug and body with a positive seal of pressurized lubricant. This penny's worth of prevention saves countless dollars in lost product, maintenance, and down-time.

Rockwell-Nordstrom, *the original lubricated plug valve*, has set outstanding performance records for forty years. Why not specify the valve and lubricant combination that has *proved* its dependability and economy. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

*a registered trademark of Rockwell Manufacturing Company

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

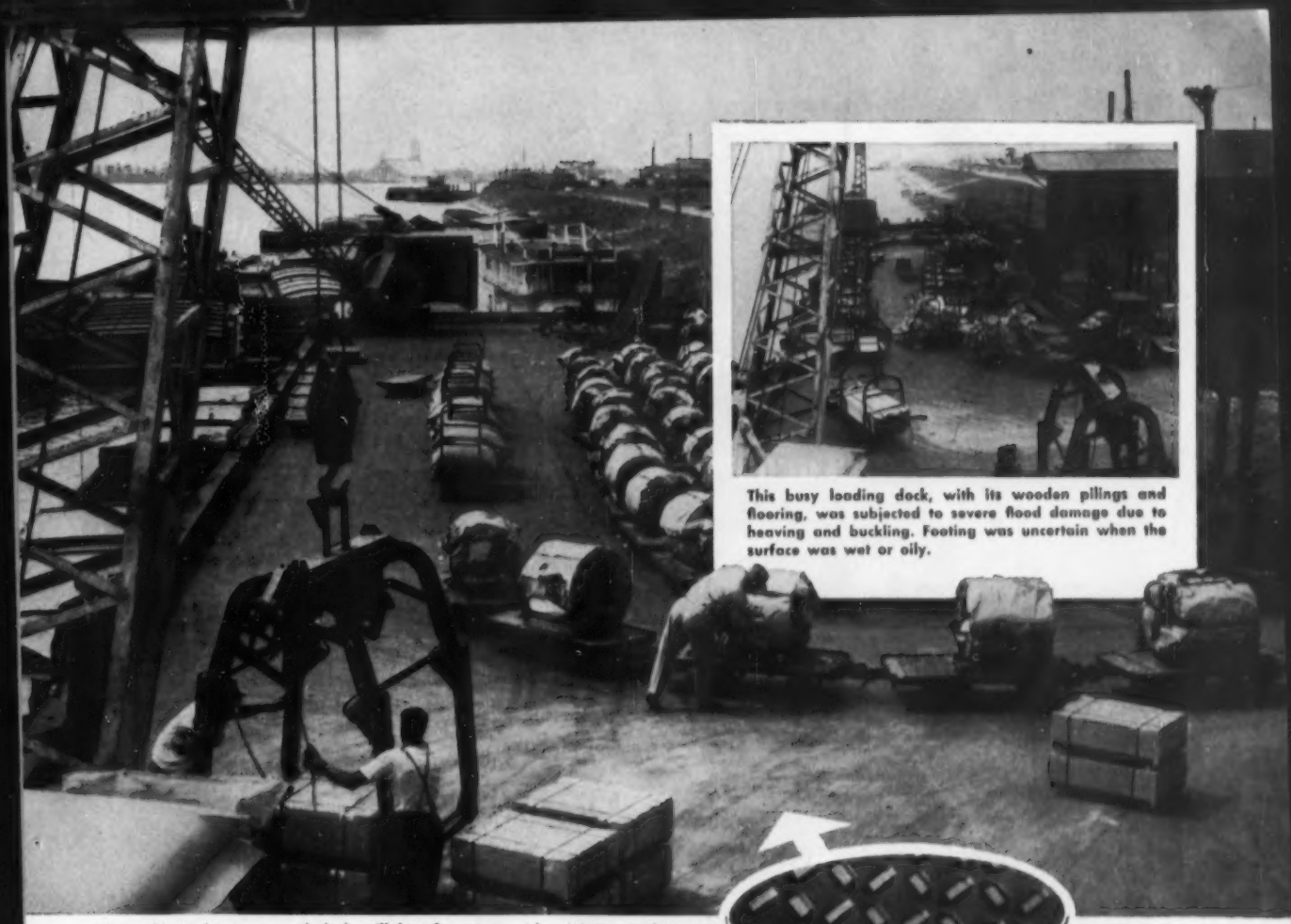
Lubricant Seating
Controls Abrasive Slurries

Slurries and entrained solids raise havoc with ordinary valves. Erosion and corrosion soon cut into vital seating areas and ruin the metal-to-metal closure. This can't happen in Rockwell-Nordstrom valves because the seal is a constantly renewed film of tough lubricant under pressure. Seating areas are *never* exposed. And there are no pockets or cavities in the Nordstrom valve to collect deposits that ruin other valves.

The Rockwell-Nordstrom combination of the right valve and the right lubricant for every slurry service will give you a more dependable operation—at lower yearly cost—than any other valve you've ever used. Write today for full information. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF



This busy loading dock, with its wooden pilings and flooring, was subjected to severe flood damage due to heaving and buckling. Footing was uncertain when the surface was wet or oily.

Now, this Multigrip-covered dock will last for years with minimum maintenance. Evenly spaced "safe-tread" risers give sure-grip traction plus simplified cleaning and exceptional drainage. Permanent support is given by USS H-Beam Bearing Piles.

Dock flooring replaced **once and for all**

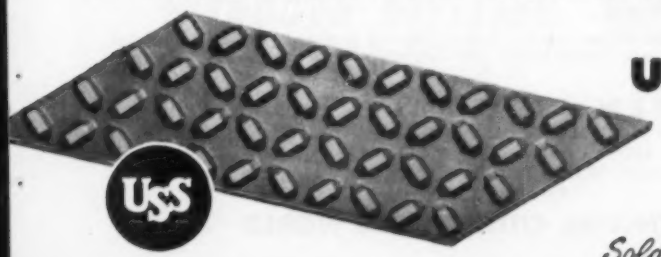
with USS Multigrip Floor Plate

Periodically, the waters of the mighty Mississippi rise . . . causing considerable damage to riverside loading docks. The force of these turbulent flood waters buckles, and often collapses, wooden pilings and flooring. Damage like this means expensive repairs, as well as costly delays in loading operations. Such was the case with a busy dock owned by Mississippi Valley Barge Line Company.

Flood losses and resulting delays were eliminated when Stupp Brothers Bridge and Iron Co. of St. Louis, and Massman Construction Company, Kansas City, Mo., used U.S. Steel Multigrip Floor Plate to renovate this dock, which has already had the sub-structure replaced with steel bearing piling. Now, Multigrip Floor Plate, with flat-topped, "safe-tread" risers, will give many years of sound support plus sure-grip traction for feet and the small diameter wheels on fork trucks and freight dollies.

Indoors or out, USS Multigrip Floor Plate is a wise investment in long-term plant safety. Each "safe-tread" riser with its clean, flat top, acts as an accident stopper in danger areas. Because Multigrip is made of tough steel, it gives extra years of low maintenance service in heavy traffic areas. Multigrip is available in large plates (cutting installation waste) and may be bent or formed for structural use.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

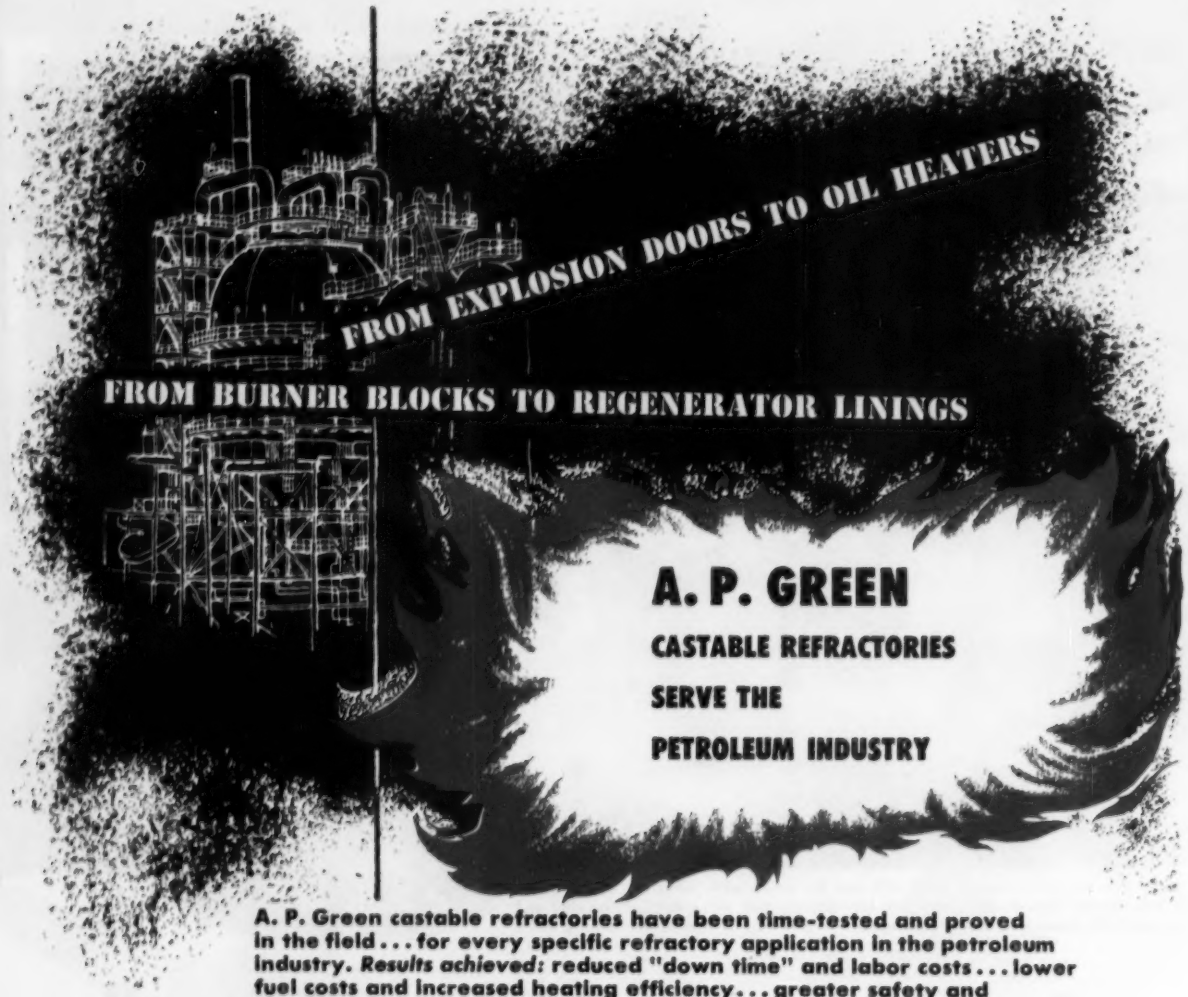


USS multigrip

FLOOR PLATE

Sold by leading distributors from coast to coast

UNITED STATES STEEL



A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.

For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

KAST-SET — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

KAST-O-LITE — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

CASTABLE INSULATION NO. 20 — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

CASTABLE BLOCK MIX — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

CASTABLES FOR GUN APPLICATION . . . SK-7 — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

KS-4 — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.
Plants: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
IN CANADA: A. P. GREEN FIRE BRICK COMPANY, LTD.
Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

to remove

H_2S

CO_2

use

Monoethanolamine

Diethanolamine

high purity
NITROGEN DIVISION
chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities — chlorides and acids — these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

NITROGEN DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.
Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

to remove

H_2O

use

Diethylene Glycol

Triethylene Glycol

high purity
NITROGEN DIVISION
chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities — chlorides and acids — these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

NITROGEN DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.
Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Urea
Ethanolamines • Ethylene Oxide • Ethylene Glycols • Formaldehyde • Nitrogen Tetroxide
Nitrogen Solutions • U.F. Concentrate—85 • Fertilizers & Feed Supplements

- ✓ Printing Invoices
- ✓ Cancelled Checks
- ✓ Post Office Receipts
- ✓ Circulation Record Transcript
- ✓ Count and Check of Mail List
- ✓ Condition of Collections
- ✓ Original Order Test
- ✓ Expirations
- ✓ Source of Subscriptions
- ✓ Mail Subscriptions Special
- ✓ Association Subscriptions
- ✓ School Subscriptions
- ✓ Subscriptions to U. S. Armed Services
- ✓ Arrears over Three Months
- ✓ Credit Subs. Cancelled for Nonpayment
- ✓ Short Term Subs. in Arrears
- ✓ Duplications on mail lists
- ✓ Circulation by Population Groups
- ✓ Geographical Analysis
- ✓ Term Subscriptions in Bulk
- ✓ Names for Verification Letters
- ✓ Back Copy Subscriptions
- ✓ Dealer Ledger Check
- ✓ Condition of Dealer Collections
- ✓ Dealer Returns
- ✓ Single Copy Sales
- ✓ Single Copy Sales to U. S. Armed Services
- ✓ Bulk Sales
- ✓ Premiums
- ✓ Promotion
- ✓ Contests
- ✓ Combination Sales
- ✓ Clubs
- ✓ Special Prices
- ✓ General Books and Controls
- ✓ Analysis of Disbursements
- ✓ Cash Receipts

The Check List Behind A.B.C. Circulation FACTS

Study the check list at the left. It's the one used by a field auditor of the Audit Bureau of Circulations when he makes his careful annual examination of our circulation books and records. The answers to questions like these appear in our A. B. C. Audit Report so that you can make your advertising investments on the basis of facts.

Any research, to produce valid and useful results, must be based on such worthwhile questions, accurately answered. Because we're members of the A. B. C., advertisers *know* the audience they get for the sales messages they place in our publication.

The Audit Bureau of Circulations is a voluntary, nonprofit association founded forty years ago by advertisers, advertising agencies and publishers to bring order out of circulation chaos. The Bureau sets standards for net paid circulation, verifies circulation by field audit and issues A. B. C. Audit Reports.

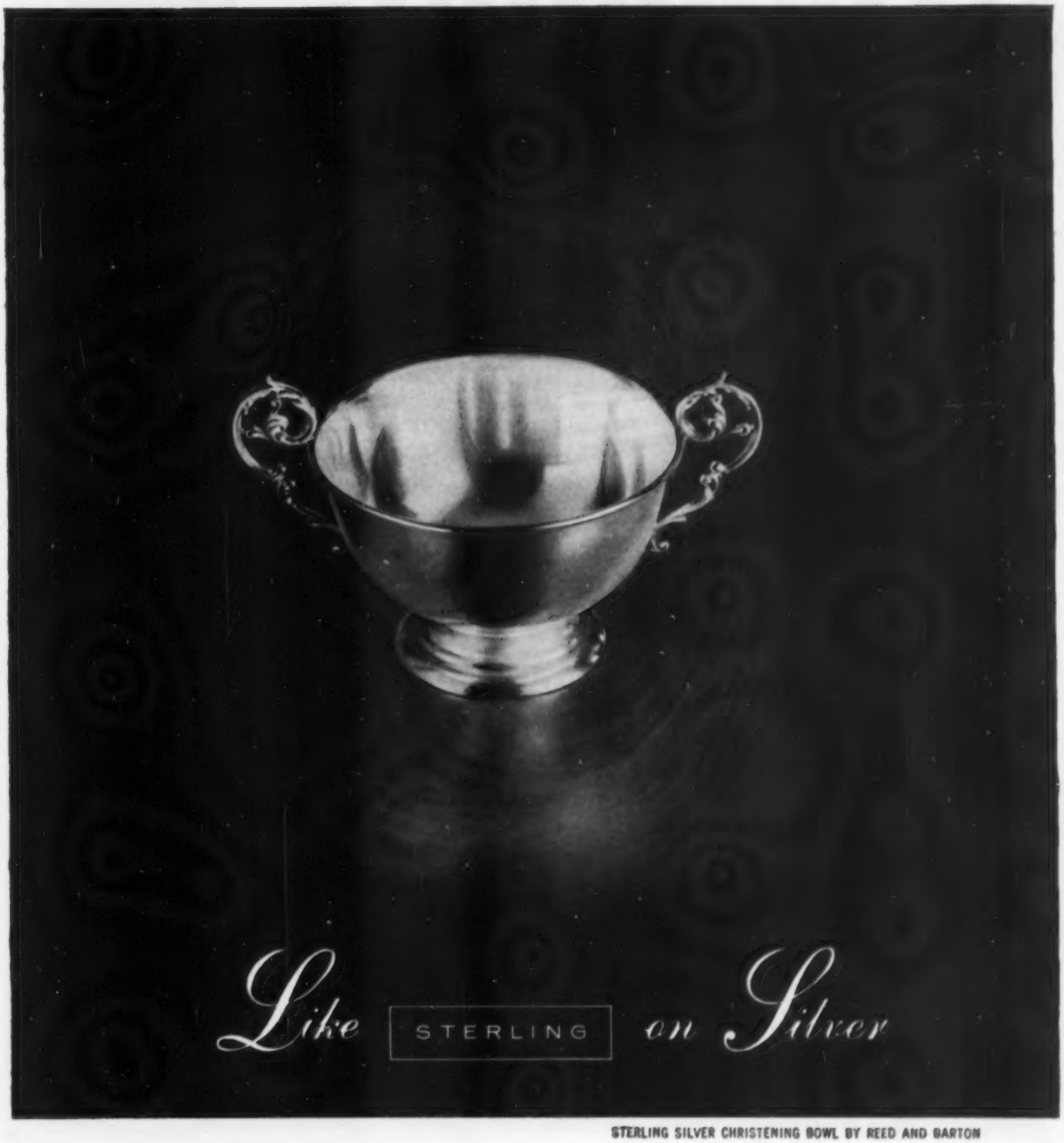
Our A. B. C. report accurately states and analyzes our circulation; tells exactly how much we have, where it goes, how we obtain it. We're proud to be among the 3575 Bureau members who have helped make such A. B. C. FACTS the basic measure of circulation value.

WRITE FOR YOUR COPY OF OUR LATEST

A.B.C. REPORT

PETROLEUM REFINER

A.B.C. — 40 YEARS OF IMPARTIAL FACT-FINDING AND FACT-REPORTING



STERLING SILVER CHRISTENING BOWL BY REED AND BARTON

AUDITED PAID CIRCULATION ABC

This symbol means quality circulation. Only publications with paid circulations are members of ABC. They are worth the advertiser's dollar because they have proved to be worth the reader's dollar.

STUBBORN!

Chase® Antimonial Admiralty Heat Exchanger Tubes *RESIST DEZINCIFICATION!*

Dezincification holds no fears for the users of Chase Antimonial Admiralty Heat Exchanger Tubes! For *this* special alloy can give *years* of extra service under the most corrosive conditions!

Rugged testing in Chase laboratories, plus careful manufacturing in Chase mills, team up to give Chase Antimonial Admiralty a longer, healthier life span. To you, this can mean lower operating costs, fewer breakdowns, longer waits between tube replacements.

Enjoy these benefits! Insist on Chase Antimonial Admiralty!

CHASE WAREHOUSE STOCKS: Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co. **Handled by Vinson Supply Co.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

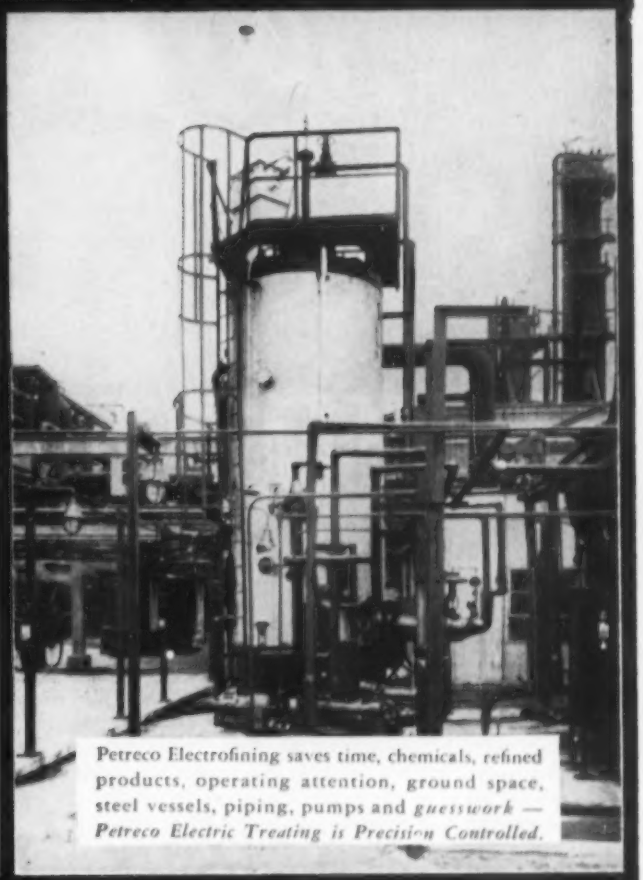
The Nation's Headquarters for Brass & Copper (†sales office only)

Albany†	Chicago	Detroit	Los Angeles	New Orleans	Rochester†
Atlanta	Cincinnati	Grand Rapids†	Louisville†	New York	St. Louis
Baltimore	Cleveland	Houston	Milwaukee	Philadelphia	San Francisco
Boston	Dallas	Indianapolis	Minneapolis	Pittsburgh	Seattle
Charlotte†	Denver	Kansas City, Mo.	Newark	Providence	Waterbury

A New Concept in Distillate Treating

PETRECO

The Petreco Electrofining equipment provides one pass operation, more intensive contact and minimum entrainment loss. It holds chemical (acid, caustic, doctor solution) consumption to a minimum. In addition to these advantages, Petreco Electrofining is carried on in a single, closed unit, and is a continuous, automatically controlled process. In treating the average kerosine, gasoline or gas oil stream, one small Petreco unit will usually replace three or four 10′ x 30′ (or larger) vessels.



Petreco Electrofining saves time, chemicals, refined products, operating attention, ground space, steel vessels, piping, pumps and *guesswork — Petreco Electric Treating is Precision Controlled.*

Specialized Electric Petroleum Processing

DESALTING • DEHYDRATING
DISTILLATE TREATING • LUBE OIL TREATING • SEDIMENT SEPARATION
DESAPONIFICATION

For complete information, write or call

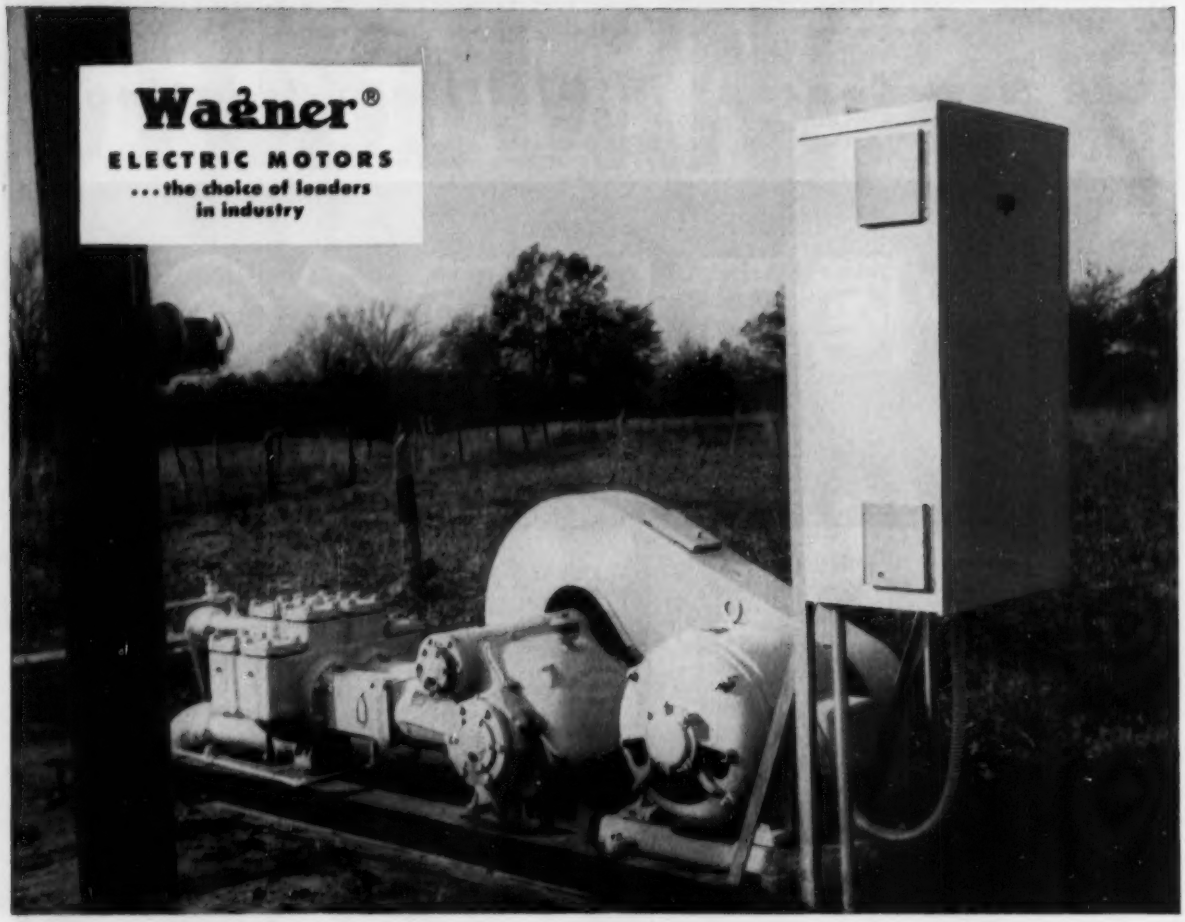
PETRECO®

A DIVISION OF PETROLITE CORPORATION

3202 South Wayside Drive, Houston 1, Texas
1390 East Burnett Street, Long Beach 6, California

DT3

For more data on advertised products, use Readers' Service Cards, last page.



portable power for the petroleum industry

American Oil Pipe Line Company pipes crude oil from lease tanks to storage tanks of oil refineries. The network of pipe in a field is called a "gathering system."

At various gathering system locations, you'll find gathering pumps which keep the heavy crude oil coursing through the pipeline. These gathering pumps are put on skids so they can be moved about to give the system greater flexibility. American can move its pumps quickly and easily whenever new pipe is added or old pipe is abandoned.

A 25 horsepower Wagner motor is the hard-working heart of each of these portable pumps. Wagner motors are chosen for this application because they go about their ceaseless job of hurrying crude oil to the refinery with complete dependability and a minimum of maintenance.

Perhaps you have a specialized motor application . . . if so, remember, there's a Wagner motor to fit every need . . . a complete line for all current specifications with a wide variety of enclosure types and mountings.

Your nearby Wagner engineer can help you select the *right* motor to meet your specifications. Call the nearest of our 32 branch offices or write us.

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

WH59-B

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

HIGHEST ABRASION RESISTANCE— HIGHEST CHEMICAL RESISTANCE

ever built into a fire hose

It's U. S. Matchless CARBOLIZED!

Flexible! Easy to rack!

This is the most rugged hose ever built for the refining and petro-chemical fields.

Yet it is the lightest and most flexible of all covered fire hose! Ask the fire crews who handle it.

A fast-running, husky fire crew can pull it over jagged concrete, around sharp pillars—without any damage to it. Kinking or being run over does no harm. Even rats and termites can't chew it (believe it or not, over 600 feet of ordinary fire hose were eaten up last year in just *one* Texas plant). U. S. Matchless® has a special cord ply carcass made of "Ustex" fabric, resistant to rot and mildew. The white (or black) oil-proof neoprene cover resists oils, acids, fumes and strong, hot sunlight.

Other hose made by United States Rubber Company for the refining and petro-chemical fields include:

- Flexlite, the all-Dacron* Single Jacket (weighs 48 lbs. per 100 ft.) (withstands 500 lbs. test pressure)
- "Reliance®" Double Jacket Dacron reinforced (weighs 50 lbs. per 100 ft.) (withstands 400 lbs. test pressure)
- "Reliance" Double Jacket Dacron reinforced (weighs 54 lbs. per 100 ft.) (withstands 600 lbs. test pressure)

Get in touch with any of our selected distributors or any of the 27 "U. S." District Sales Offices. Or write address below.

*DuPont's trademark for its polyester fiber.

"U. S." Research perfects it..."U. S." Production builds it...U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

For more data on advertised products, use Readers' Service Cards, last page.

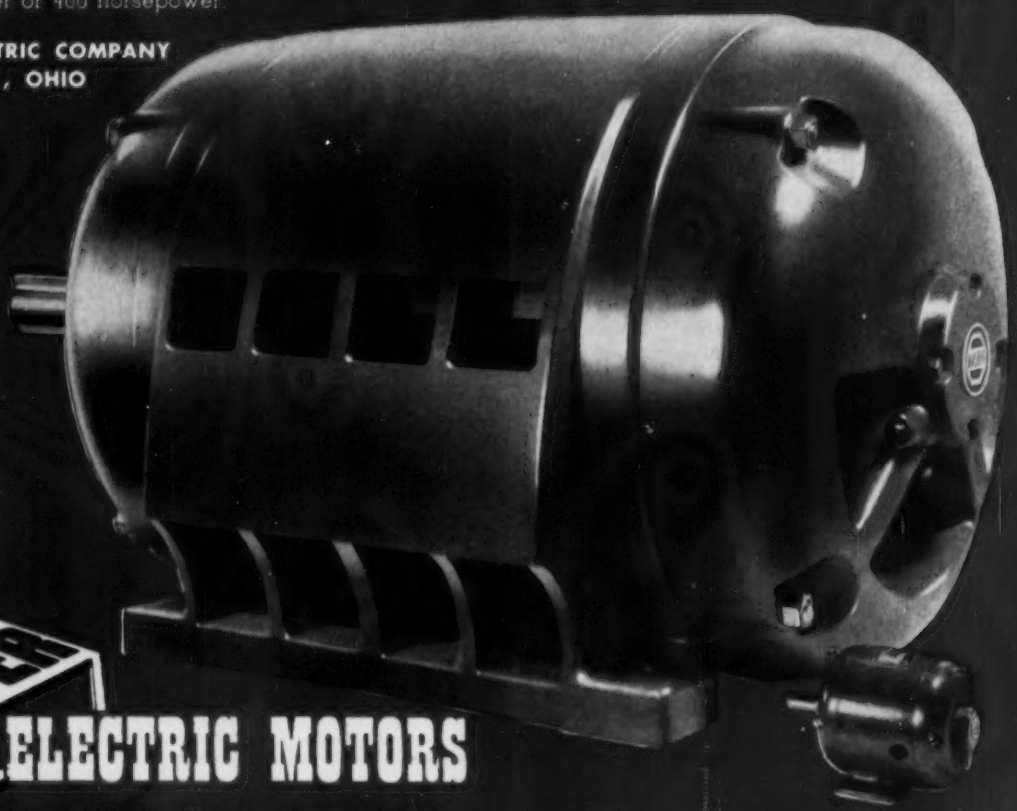
Squirrel cage motors, slip ring motors, synchronous motors, repulsion induction motors, capacitor motors, direct current motors . . . open, enclosed, splash-proof, fan-cooled, explosion-proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with electric brakes . . . with mechanical and electronically-controlled variable speed units . . . with fluid drives . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

And all of these, the electric motors . . . the electric brakes . . . the fluid drives . . . the gear reduction units . . . the variable speed drives . . . all are designed so they can be easily combined together to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT mounting features in one compact power drive.

That's the horsesense way to use horsepower whether you want 1/8 horsepower or 400 horsepower.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

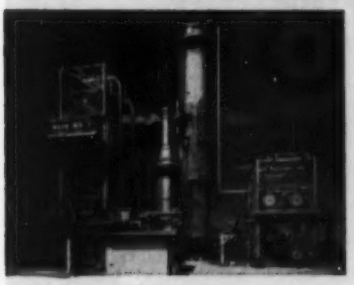
1/8 TO 400
HORSEPOWER



MASTER
ELECTRIC MOTORS

McMURREY REFINING COMPANY

expands . . . modernizes . . . attains highest quality standards



McMURREY REFINING COMPANY
TYLER, TEXAS

June 22, 1955

SUBJECT: Blaw-Knox Company
Jobs #9220-1 to
9220-12, incl.,
9221, 9223 & 9292
at McMurrey Refining
Company, Tyler, Texas

Blaw-Knox Company
Chemical Plants Division
P. O. Box 778
Pittsburgh 30, Pa.

Attention: Mr. E. S. Wright,
Manager of Construction

Gentlemen:

We wish to commend you and your organization for the high quality workmanship, labor relations, customer relations, job cleanliness and efficiency on our expansion and modernization program which was started in early 1953 and is now nearing completion.

Your Construction Superintendent, Mr. R. E. Squire, has co-operated with our engineering department and operating department 100% and is to be commended for cost-consciousness and labor relations; we did not have a labor stoppage in the two year construction and revamp program.

We extend the invitation to you of calling on us at any time for recommendations on Blaw-Knox construction and/or Mr. Squire's ability as a job superintendent.

Yours truly,

McMURREY REFINING COMPANY

M. H. McMurrey, President

MHM:bjf

JOBS ENGINEERED AND COMPLETED BY BLAW-KNOX

9220-1	Electrical distribution system
9220-2	Utility systems and miscellaneous refinery facilities
9220-3	Rerouting McMurrey Creek
9220-4	Overall plant operation study
9220-5	Revisions to crude unit
9220-6	Refinery oil separators, blowdowns and flares
9220-7	Interconnecting process lines between units
9220-8	Storage and products lines from units
9220-9	Revamp #1 crude unit
9220-10	Revamp thermal cracking unit
9220-11	Revamp light ends facilities
9220-12	Revamp fluid catalytic cracking unit
9221	New 8,000 BPSD decarbonizing unit
9223	New 10,000 BPSD crude unit
9292	New aviation gasoline plant including a 1300 BPSD alkylation unit, related utilities systems, buildings, storage tanks and auxiliaries

A program of expansion and modernization of the McMurrey Refining Company, instituting the latest refinery techniques, has resulted in increased production, lower residual yields and higher octane ratings. Blaw-Knox engineers are proud to have played so important a part in engineering, revamping and constructing the various units and related systems.

BLAW-KNOX COMPANY

Chemical Plants Division

Pittsburgh 22, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.

MARLEY IS TESTING COOLING TOWERS

AND HERE IS THE RECORD

TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULT	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	[1]Degrees Cold Water Temp.	[1]Percent Capacity
1	Air Conditioning—West Coast	400	90°	80°	70°	+0.80°	+9.4%
2	Air Conditioning—Gulf Coast	6,500	101.3°	88.5°	80°	—0.40°	—4.3%
3	Chemical Plant—East Coast	18,500	104°	89°	76°	+0.50°	+3.8%
4	Chemical Plant—East Coast (1 of 4 duplicate units)	27,500	103°	88°	76°	—0.40°	—3.2%
5	Power Plant—Southwest	57,500	109.6°	92.6°	78°	—0.04°	—0.4%
6	Petroleum Refinery—Gulf Coast	3,400	115°	80°	70°	+0.90°	+8.5%
7	Power Plant—South Central	83,000	108.1°	90°	76°	—0.04°	—0.4%
8	Power Plant—Mountain States	45,000	105°	83.7°	63°	+0.20°	+0.8%
9	Petroleum Refinery—Gulf Coast	15,000	111°	90°	82.5°	+0.70°	+7.7%
10	Petroleum Refinery—Gulf Coast	36,570	120°	90°	82°	—0.60°	—4.4%
11	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.86°	—4.4%
12	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.51°	—2.7%
13[3]	Power Plant—East Central	13,000	101°	85°	75°	—3.70°	—24.3%
14	Power Plant—Mid-Central	44,000	100°	86°	74°	+0.50°	+4.0%
15	Power Plant—South Central	83,000	108.1°	90°	76°	—0.80°	—4.3%
16	Chemical Plant—South	40,000	103.3°	85°	78°	—0.30°	—3.0%
17	Power Plant—North Central	37,000	100.5°	83°	72°	+1.20°	+9.6%
18	Petroleum Refinery—East Coast	15,570	115°	85°	76°	+1.10°	+9.0%
19	Power Plant—Mountain States	15,570	115°	85°	76°	+1.10°	+9.2%
20	Chemical Plant—Gulf Coast	40,750	123°	90°	80°	—0.16°	—1.2%
21	Chemical Plant—Gulf Coast	11,000	116°	90°	80°	+1.80°	+13.2%
22[2]	Retest of Tower Reported in No. 14	44,000	100°	86°	74°	+0.45°	+4.8%
23[4]	Retest of Tower Reported in No. 11	70,450	102.6°	86°	70°	+0.20°	+1.1%
24[4]	Retest of Tower Reported in No. 12	70,450	102.6°	86°	70°	+0.33°	+1.8%
25	Petroleum Refinery—East Central	6,000	125°	90°	75°	—0.46°	—2.6%
26[5]	Petroleum Refinery—Gulf Coast	10,000	120°	85°	79°	+0.30°	+3.2%
27	Power Plant—Southwest	72,000	112°	92°	78°	+1.05°	+6.6%
28	AEC—East Central (1 of 2 duplicate units)	62,798	132.3°	90°	80°	+0.31°	+3.5%

NOTES: 1) Plus indicates capacity exceeding specified performance; minus denotes deficiency. 2) Tested to determine loss of performance due to extensive settling of basin and resultant misalignment of structure. 3) Retested at higher wet bulb. 4) Retested at contract (higher) horsepower. 5) Tested in accordance with Cooling Tower Institute test procedure (ATP-105 adopted May 1, 1955) and observed by CTI representative.

HERE IS THE RECORD — a consecutive list of ALL acceptance tests conducted by Marley during the 1954-1955 test seasons. All are full-scale tests conducted in strict accordance with specified methods.

Towers tested were of many sizes and capacities, operating under widely varying conditions. Geographically, these tests spanned the entire country and included towers sold since 1950, located at elevations up to 5,000 feet.

HERE IS THE RECORD that offers **more positive assurance of performance satisfaction than any guarantee ever written.** It shows why Marley has the complete confidence to insist that you TEST YOUR TOWER.

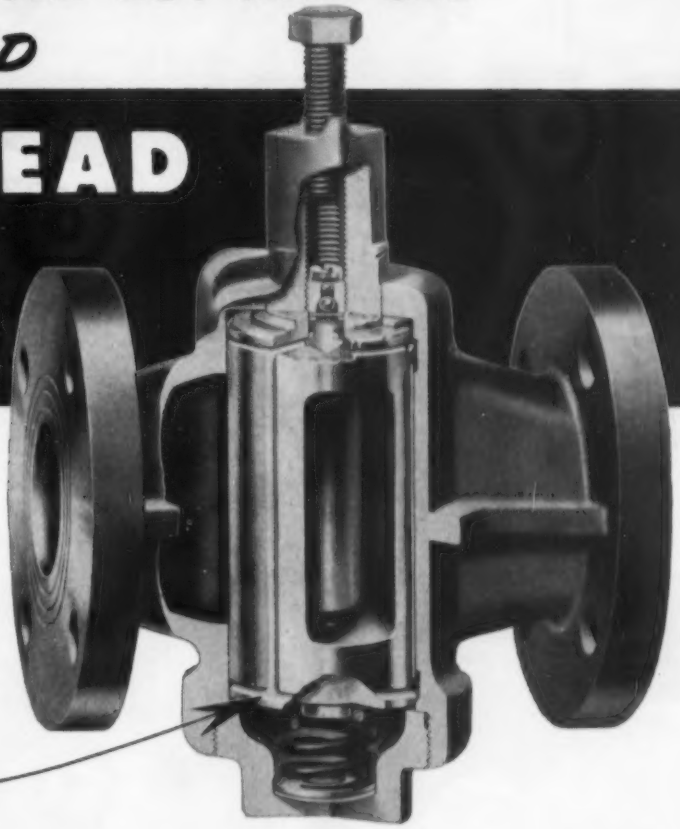
MARLEY

The Marley Company

Founder-member of the Cooling Tower Institute

Kansas City, Missouri

No. 5* of 12 REASONS WHY
YOU SHOULD BUY AND USE
LOW-PRICED
HOMESTEAD
Lubricated
PLUG VALVES



*SELF-FREEING PLUG PREVENTS STICKING

Homestead's exclusive completely controlled lubricant system positively prevents sticking by its instant, piston-like movement of the plug downward at the start of each lubrication. Spring and line pressure return it to stem-sealed position.

This is only **one reason why you should buy and use low-priced** HOMESTEAD LUBRICATED PLUG VALVES.

HERE ARE ALL TWELVE

1. Extra long valve life assured by very close tolerance between sealing surfaces.
2. Straight line fluid flow—streamlined ports—minimum resistance to flow—minimum pressure drop.
3. Triple head seal—two lubricant rings and reinforced Teflon stem seal prevent leakage.
4. Easy turning—plug floated on Teflon washer and reinforced Teflon ring.
5. Leak-proof double ball and lubricant sealed check valve. No springs. No maintenance.
6. Full-threaded screw prevents dirt being forced into lubricant system.
7. Quarter-turn fully opens or closes.
8. Reinforced Teflon stem seal—no cold flow—continuous, positive seal.
9. Seating surfaces protected in both open and closed positions.
10. High pressure lubricant system provides full lubricant seal around ports.
11. Self-freeing plug prevents sticking.
12. Two lubricants handle most services.

FOR CATALOG AND COMPLETE DETAILS MAIL COUPON TODAY

HOMESTEAD
VALVE MANUFACTURING COMPANY
"Serving Since 1892"

P. O. Box 45 **Coraopolis, Pa.**

Without obligation, send Reference Book 39—Section 5 on HOMESTEAD LUBRICATED PLUG VALVES.

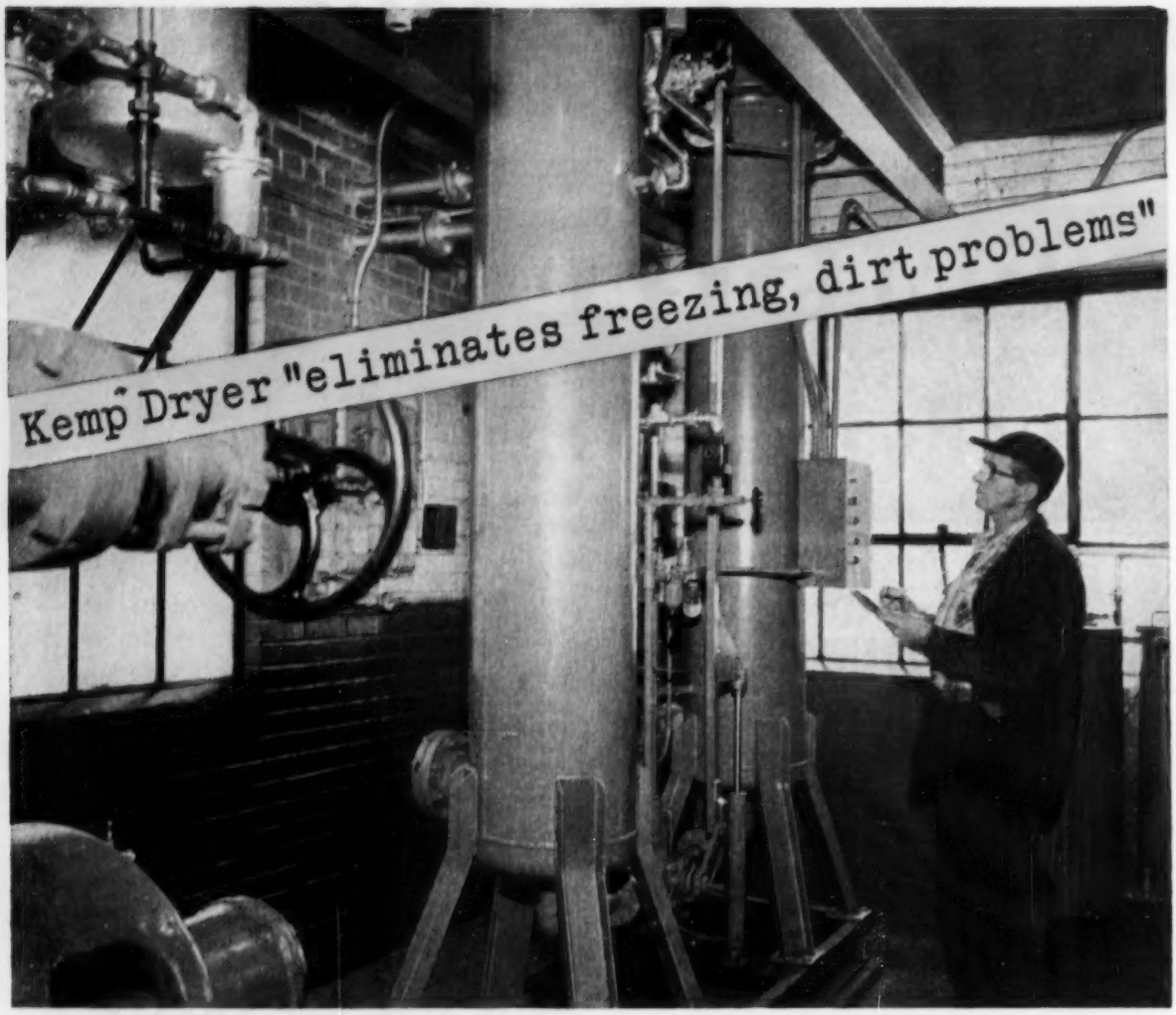
NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

For more data on advertised products, use Readers' Service Cards, last page.



Quaker State Reports: *Kemp Dryer protects instrument lines from freezing at temperatures of 25° below zero*

Instrument failure is now a rare thing at the Quaker State Refining Corp., Farmers Valley, Pa. Quaker State installed a Kemp 300-E Oriad Dryer in December, 1954, and according to Process Supervisor Joe Brown it has really done a job safeguarding instrument operation.

Kemp Saves Time, Labor

The company no longer has to steam trace or insulate instrument air lines. A longer period of time can be allowed between servicing instruments. Even at temperatures of 25° below zero, none of the lines froze. And to further save time and manpower, the dryer is fully automatic! Between its "elimination of instrument failure and ease of operation," Kemp earned its place on the Quaker State team.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases, or liquids, contact Kemp engineers now. For complete facts and technical information, write for Bulletin D-27.

KEMP OF BALTIMORE

DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

For more data on advertised products, use Readers' Service Cards, last page.

EXPLOSION PROOF

IN THE PRESENCE OF . . .

Totally enclosed explosion-proof Century motors insure complete confidence with many features.

A few are:

- Vital parts protected – Sealed in
- Reverse rotation without changing fan
- Uniform ventilation
- Unusually free from vibration
- Lubricated for years – but *CAN* be serviced on the spot.

Ethyl ether vapors

Gasoline

Petroleum

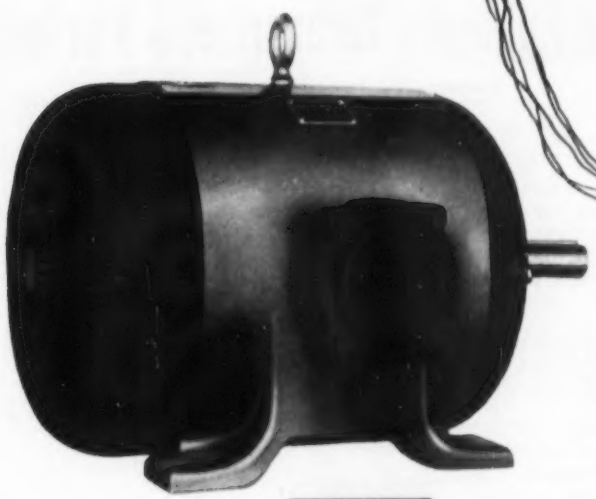
Naphtha

Alcohols

Acetone

Lacquer solvent vapors

Natural gas



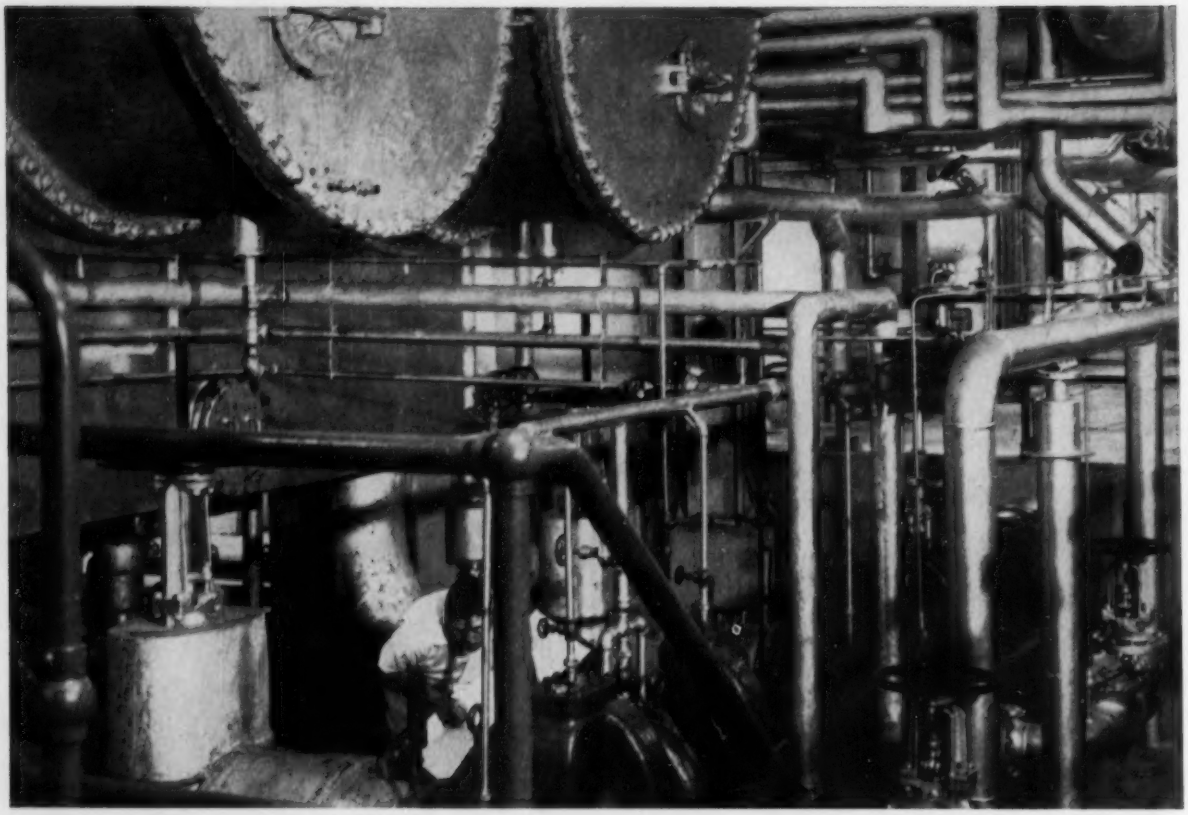
Century

Class I, Groups C and D
Explosion-Proof Motors
Underwriters Approved
Three phase: 1 to 100 H.P.
Single phase: 1 to 20 H.P.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION – TULSA, OKLAHOMA
Serving The United States and Canada

For more data on advertised products, use Readers' Service Cards, last page.



Deaerating Condenser Exceeds Guaranteed Performance

	guarantee	actual performance
Condensate depression	0	0
cc of oxygen per liter in condensate	0.01	no measurable amount

This 50,000 sq. ft. steam surface condenser was installed by Lummus for Carolina Power & Light Company, Goldsboro Steam Electric Generating Plant, Goldsboro, N. C., Ebasco Services, consulting engineers. The unit is a deaerating type condenser of Lummus' patented design, serving a 66,000 KW turbine.

After three years of operation, it is still meeting and exceeding the original performance guarantees, as tabulated above, under all conditions of operation.

The unit was designed to condense 400,000 pounds/hr. of exhaust steam from the turbine at 2.10" Hg. abs. and deaerate the condensate. In addition to the condensate the unit must deaerate 50,000 pounds/hr. of drains from feed-water heaters and 100,000 pounds/hr. of cold make-up water at ambient temperature. The drains and make-up water enter the condenser above the tube bank and are deaerated in the Lummus patented deaeration section. Tests run with supersaturation of air in the cold make-up were handled with complete removal of oxygen and other dissolved gases without any unbalancing of the system.

Lummus-designed equipment gives results of this caliber consistently. May we sit in with your engineers on the project coming up?

THE LUMMUS COMPANY, Heat Exchanger Division, 385 Madison Avenue, New York 17, N.Y. • Atlanta • Boston Chicago • Cincinnati • Cleveland • Dallas • Denver Detroit • East Chicago (Indiana) • Houston • Kalamazoo Kansas City • Los Angeles • Minneapolis • Nashville New Orleans • Newton (Iowa) • Niskayuna (New York) Omaha • Pittsburgh • Salt Lake City • San Francisco Springfield (Mass.) • Syracuse • Toledo • Wayne (Pa.) Athens • Buenos Aires • Caracas • The Hague • Lima London • Mexico City • Montreal • Paris • Rome • San Juan

Fabricated Piping Division Plant at East Chicago, Ind.

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers Pipe Line Coolers.

LUMMUS
HEAT EXCHANGER DIVISION

LUMMUS

THE LUMMUS COMPANY, HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N. Y.

Here's how to

solve your low capacity flow control problems in refinery operations

Controlled volume pumps are flow control instruments

boiler and cooling tower water treatment

vacuum distillation (*anti-foam addition*)

platforming (*metering make-up caustic*)

research (*controlling pilot plant streams*)

corrosion inhibition (*pumping inhibitors to tower tops*)

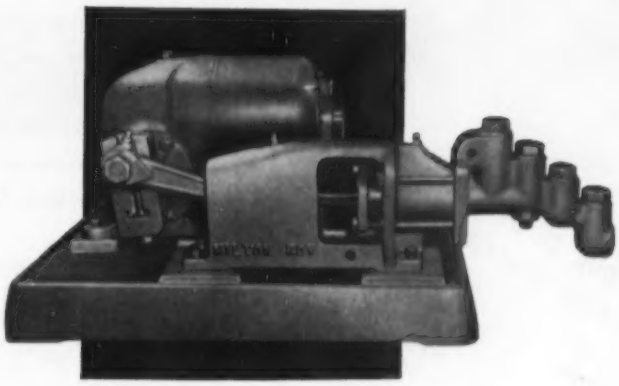
fuel oil treating (*adding oxidation inhibitors*)

crude desalting (*de-emulsifier metering*)

finished gasoline treating (*inhibitors, dyes, octane appreciators*)

caustic treating of lube oil

acid treating of distillates



INDICATED, left, are a number of typical applications for Milton Roy controlled volume pumps throughout petroleum processing operations. Wherever there's need for controlled metering of additives, reagents, and other low-capacity fluids to process, controlled volume pumps perform with high accuracy and dependability.

Reason: controlled volume pumps are actually flow control instruments . . . accurate to within 1%. They can be used effectively as flow controllers, ratio controllers, or as final control elements in process instrumentation. From boiler feedwater treatment . . . to metering of gasoline inhibitors . . . to pilot plant research . . . Milton Roy controlled volume pumps are giving refineries more precise control, better product quality, and significant savings on costly additives.

Milton Roy offers you long experience in handling low capacity flow control problems . . . in engineering complete chemical feed and automatic control systems. Write for technical information. Or, send your problem to the Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Phila. 18, Pa.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

SEND FOR 24-page illustrated technical bulletin: Bulletin 1253, "*Controlled Volume Pumps in Process Instrumentation.*" Clear, informative text. Case histories and diagrams on a variety of control applications.

milton Roy
CHEMICAL FEED SYSTEMS

For more data on advertised products, use Readers' Service Cards, last page.

THIS ONE'S ON US!

• We'd like a chance to help you with your refinery tubing problems —at no obligation to you. Over the past 60 years, National Tube's refinery specialists have come up against practically every existing refinery problem. From this long and varied experience we have developed 25 different steel tube analyses . . . each designed to control specific refinery conditions such as exposure, oxidation, acids, corrosion, pressure, and high and low temperatures. Every one of these analyses has been tested time and again in actual refinery service so that we know exactly what each one will do. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are presently under study.

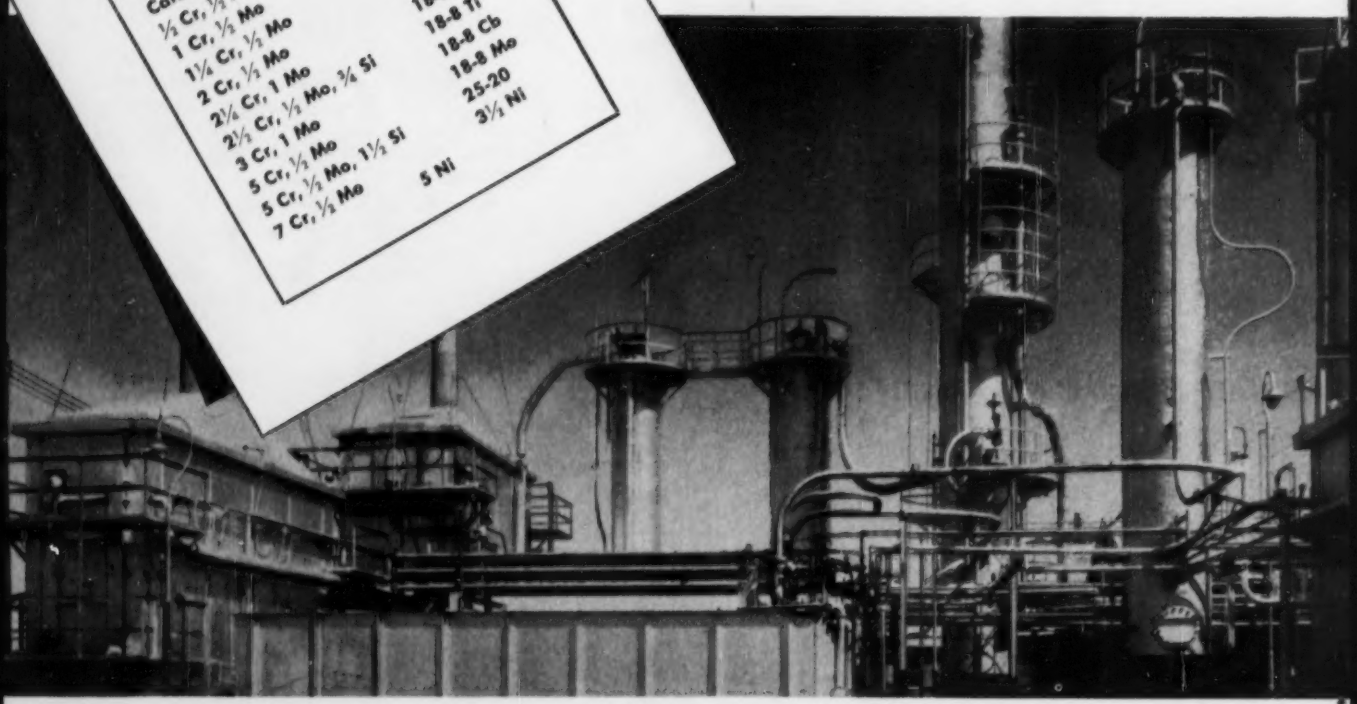
So be our guest. We'll lend an attentive ear to your refinery problems and do our utmost to find the tubing analysis that will do the best job for you at the lowest cost. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

HERE ARE OUR 25 DIFFERENT STEEL TUBE ANALYSES:

Carbon
Carbon, ½ Mo
½ Cr, ½ Mo
1 Cr, ½ Mo
1¼ Cr, ½ Mo
2 Cr, ½ Mo
2¼ Cr, 1 Mo
2½ Cr, ½ Mo, ¾ Si
3 Cr, 1 Mo
5 Cr, ½ Mo
5 Cr, ½ Mo, 1½ Si
7 Cr, ½ Mo
5 Ni
8 Cr, ½ Mo
8 Cr, 1 Mo
9 Cr, 1 Mo
12 Cr
12 Cr, Al
17 Cr
18-8
18-8 Ti
18-8 Cb
18-8 Mo
25-20
3½ Ni

National Tube Division, United States Steel Corporation, Pittsburgh, Pa.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

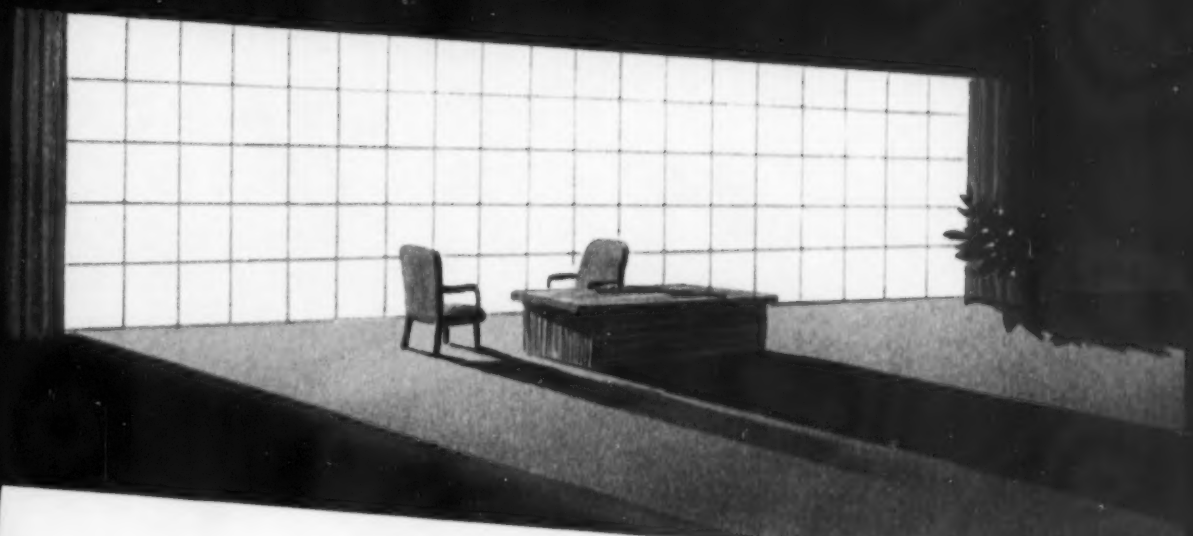


USS **NATIONAL SEAMLESS PIPE AND TUBES**

WELDS WITHOUT WELDS

UNITED STATES STEEL

an agreement has been reached...



The Heat Exchanger Division of

Western Supply Company proudly announces

their appointment as representatives for

Brown Fintube Company

in the States of Kansas, Oklahoma,

and the City of Kansas City, Mo.

WESTERN SUPPLY COMPANY • 408 North Boulder • Tulsa, Oklahoma
BROWN FINTUBE COMPANY • 300 Huron Street • Elyria, Ohio

Two Terry Turbines equipped with "trouble eliminators"

Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.

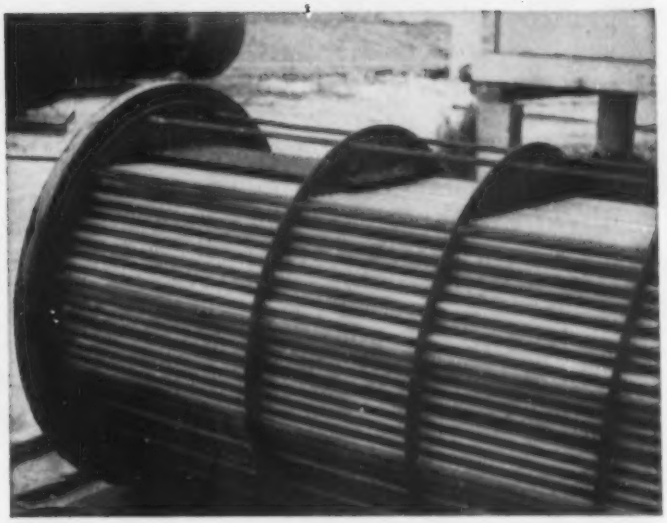
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

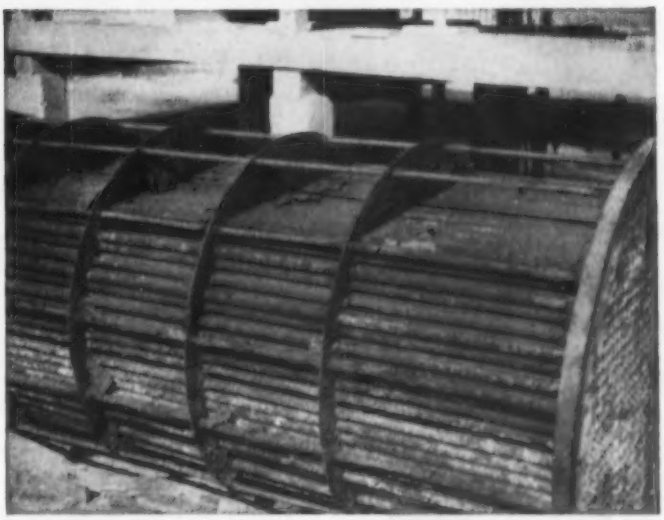
TT-1199

Which bundle do you want to find

at turn-around time?



This?.. Here's what a refiner likes to see when he pulls his bundles at turn-around time. This clean, uncorroded appearance is typical of what can be expected when you use Polyrad.



or this?.. This is an all too common sight at turn-around time. Corroded and fouled bundles such as these call either for costly replacement, repair, or cleaning.

These two bundles from the overhead condensing system of a Gulf Coast refinery tell a story. One is what the refiner likes to find at turn-around time; the other, what he is likely to discover without Polyrad.

More and more refineries have found that when they use Polyrad, the filming amine inhibitor, they can expect to find bundles free of corrosion, ready for immediate return to service. As a result turn-around time no longer need be headache time.

Why not make use of Polyrad's detergency to maintain throughput, increase heat transfer, and cut down time for maintenance?

Stocks of Polyrad are maintained throughout the country. A Hercules technical representative will be glad to discuss its application to your operating conditions.

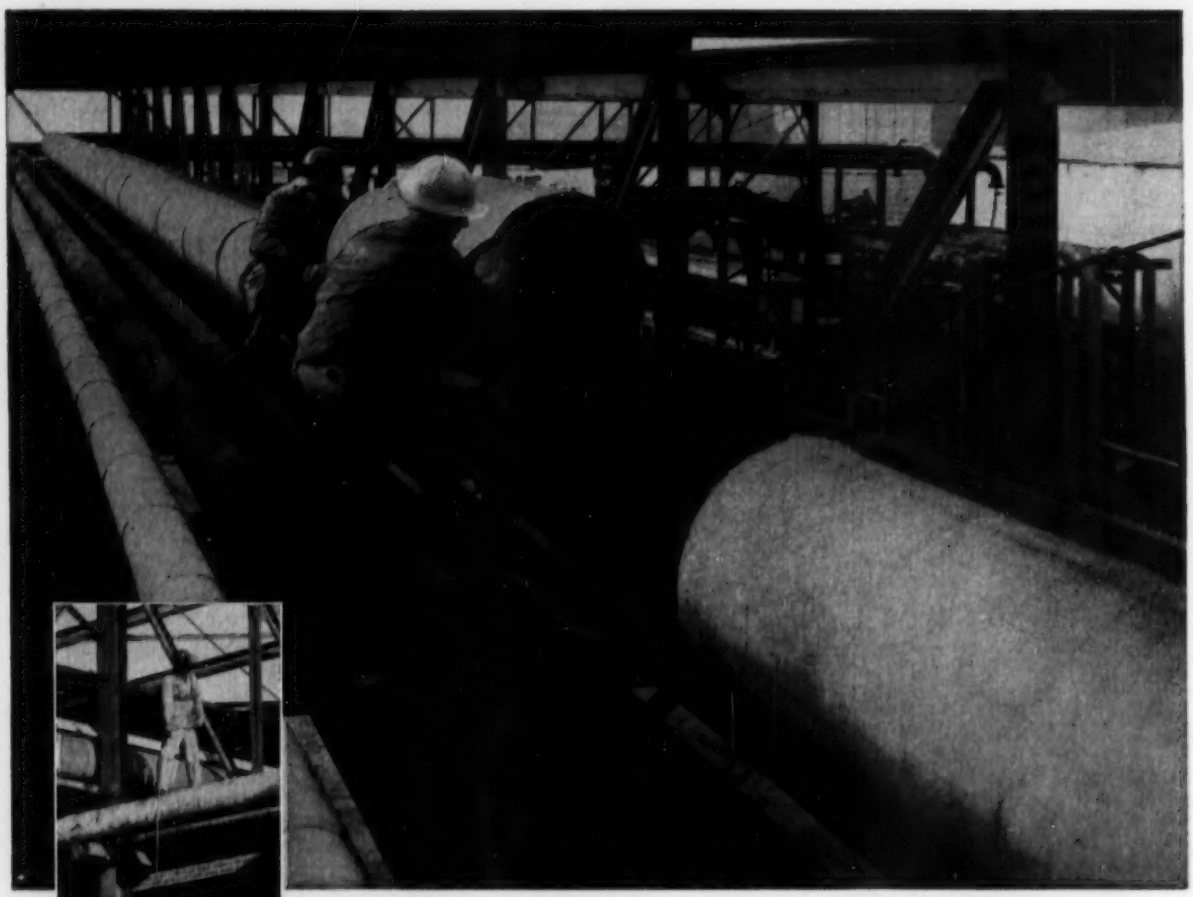
POLYRAD®

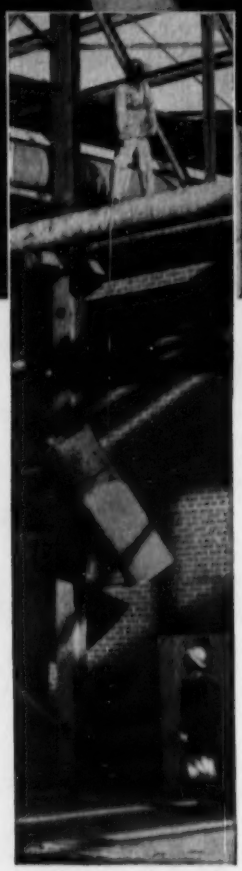
FILMING AMINE INHIBITOR

Pine Chemicals Division, Naval Stores Dept. **HERCULES POWDER COMPANY** *976 Market Street, Wilmington 99, Delaware*

NASS-6

For more data on advertised products, use Readers' Service Cards, last page.





Rugged, lightweight 6' sections are amazingly easy to handle.

New BETTER way to insulate BIG pipe

GUSTIN-BACON gb SNAP*ON

Recently, more than a mile of large 250° pipe was insulated at an eastern refinery in record time and at unprecedented low cost. The key to the success of the installation was revolutionary G-B Snap*On pipe insulation—one-piece molded cylinders of fine glass fibers.

Photos tell the story. Lightweight 6' sections of 20" Snap*On, 1½" in wall thickness, were hoisted to the job by a man with a rope. Unlike segmental pipe insulation, Snap*On required no springs or special tools for application. Two men accomplished the job quickly by snapping Snap*On sections snugly around the pipe and tracer line. A weatherproof jacket was applied in accordance with standard practice for outdoor installations. There was no breakage or waste, for flexible, resilient Snap*On is tough, does not break or crumble. No clean-up time was involved because Snap*On does not flake or chip.

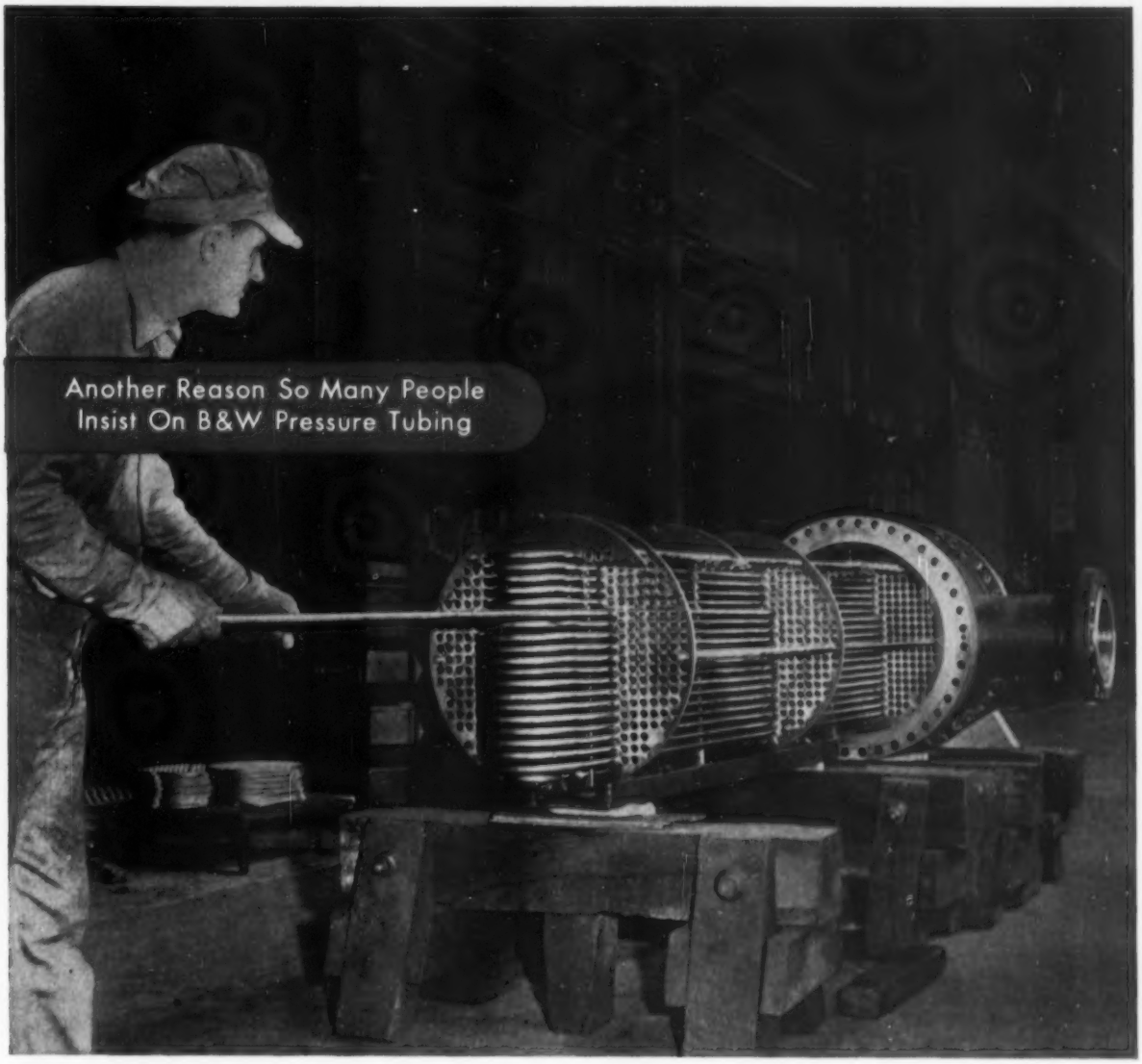
Next time you have chilled or heated piping to insulate, if you want maximum thermal efficiency, easier application and permanence, specify G-B Snap*On. There is **nothing** like it!

Write for 8-page brochure or see the Yellow Pages for name of your local distributor who carries local stocks of Snap*On.

GUSTIN-BACON *Manufacturing Company* gb

Thermal and acoustical glass fiber insulations • Pipe Coverings and fittings • Railroad gaskets and supplies

242 W. 10th St., Kansas City, Mo.



TALK ABOUT TOLERANCES!!

In oil fields, refineries, chemical plants—wherever heat transfer is important—you'll find Griscom-Russell heat exchangers on the job. The Griscom-Russell Company uses B&W Pressure Tubing to help build its reputation for efficient equipment. There's no jamming or tube distortion when threading B&W tubing through tube sheets and baffle plates. This preoccupation with close tolerances—a workaday rule at both B&W and Griscom-Russell—assures closer control, greater efficiency in many heat transfer operations. In addition, B&W Pressure Tubing is famous for uniform ductility, tight joints, ease of rolling in, and low installation cost in any heat exchanger or condenser application.

For the complete story of how B&W Pressure Tubing can improve your operation, why not call in Mr. Tubes, your link to B&W. *Or write today for Bulletin TB-329. PR.*

B&W
TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis.: Seamless Welding Fittings

TA-5022(P)

For more data on advertised products, use Readers' Service Cards, last page.

Three 125,000 #/HR STEAM GENERATORS *by* Vogt AT LION OIL COMPANY'S BARTON CHEMICAL PLANT

★ The new $30 million Lion Oil Company's Barton Chemical Plant at Luling, La. produces 300 tons daily of essential nitrogen fertilizer materials to boost crop yields and reduce unit production costs on the nation's farms.

PRINCIPAL DATA, EACH UNIT

125,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 725 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built type and package unit type steam generators. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuel burned singly or in combination. Write for bulletins.

HENRY VOGT MACHINE CO. 75th Anniversary LOUISVILLE, KY.

Henry Vogt Machine Co., Louisville, Ky.

BRANCH OFFICES:

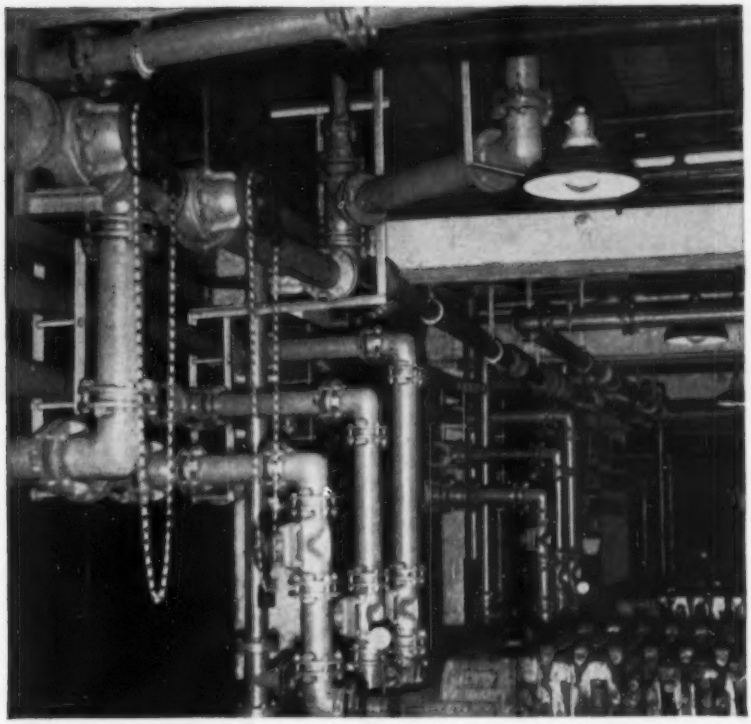
New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., San Francisco

For more data on advertised products, use Readers' Service Cards, last page.

WHERE HAVEG EQUIPMENT IS INSTALLED

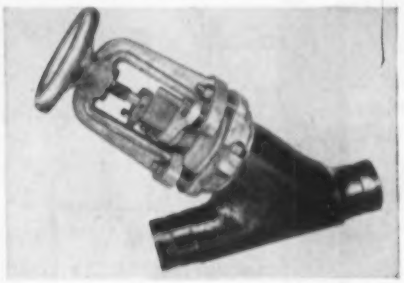
TRADE MARK REG. U. S. PAT. OFF.

PIPE • DUCT • FITTINGS • VALVES • PUMPS



A typical large installation of Haveg pipe, valves and fittings showing simple method of support required. Haveg pipe is unaffected by thermal shock, seldom requires insulation.

These Haveg parts are used in pumps for hot (104°F.) 30% Hydrochloric acid. Typical record: 33 months without replacing a single part. Many users report even longer life.



Escape potential valve troubles by buying Haveg y-valves and diaphragm valves which are smooth-molded, exactingly machined, tested in the Haveg factory. Haveg works with you on special designs!

Processing Corrosion has been Controlled!

Where liquids get hot and corrosive, it pays to consider all the facts about Haveg piping systems. Haveg has all the major ingredients for good chemical piping. Strength. Durability. Light weight. Outstanding resistance to corrosion and thermal shock.

It withstands rapid temperature changes and enables you to go into a high range of process temperatures with complete safety and a proven history of reliable performance. Haveg piping resists corrosion of practically all acids (except oxidizing acids) and lasts for years without repairs or maintenance.

Haveg *piping* is molded in diameters of ½" up and comes in lengths to 10'. It can be cut and fitted on the job (a new Haveg tool makes this even simpler—ask your Haveg engineer for details). For handling corrosive gases or fumes, Haveg *duct* is made in cylindrical or rectangular shape with lighter walls. Fume hoods, bifurcators, fan housings, fittings, all are made from Haveg and give complete containment and control of corrosives.

It's a long story telling all about Haveg, the moldable, thermosetting plastic material made of acid-digested asbestos and synthetic resins. Haveg is both a material and a service . . . it comes from America's first molders of corrosion-resistant plastic equipment. It can be as big as a 200' stack, as small as a miniature pump part. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical, proven answer to your design problems in handling hot, corrosive liquids; in fact, in all equipment that must control processing corrosion.

ATLANTA, Exchange 3821 • CLEVELAND 20, Washington 1-8700
DETROIT 39, Kenwood 1-1785 • HOUSTON 4, Jackson 6840
LOS ANGELES 14, Mutual 1105 • SEATTLE 7, Hemlock 1351
CHICAGO 11, Delaware 7-6088 • WESTFIELD, N. J., Westfield 2-7383

HAVEG CORPORATION

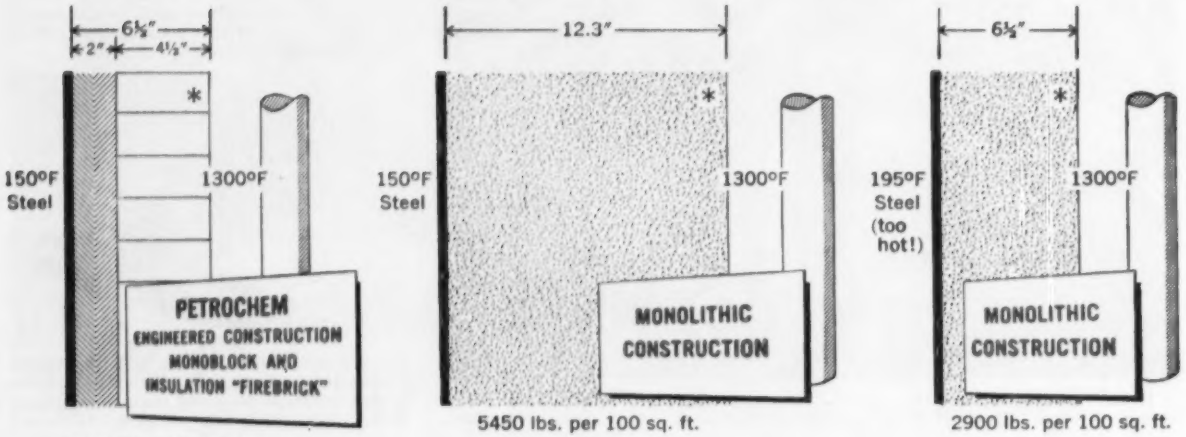
TRADE MARK REG. U. S. PAT. OFF.

900 GREENBANK ROAD • WILMINGTON 4, DELAWARE
FACTORY: MARSHALLTON, DEL. • WYman 8-2276

In furnaces as in processes compare the design to judge the advantages

As an example:

The wall construction of all Petrochem-Isoflow Furnaces is designed for 150°F maximum outside shell temperature.



1250 lbs. per 100 sq. ft.

5450 lbs. per 100 sq. ft.

2900 lbs. per 100 sq. ft.

*Based on B & W values.

The Petro-Chem design provides a thoroughly engineered wall construction. It is built with two tiers of monoblock supported on 18 inch centers and a circular arched wall of insulating firebrick. The inside of the steel shell is protected from the possibility of corrosion by a one-eighth inch thickness of Staylastic cement. This type of construction, independently supported monoblock and the circular arch of firebrick, bonded with Smoothset mortar, assures optimum efficiency and minimum maintenance.

The use of monoblock and insulating firebrick laid as a circular arch provides many advantages over a one-piece monolithic lining, including:

1—Low weight, 2—Low heat conductivity, 3—High hot crushing strength, 4—Low expansion coefficient, 5—Resilient compressible backing, 6—Long life, 7—Nil maintenance.

Also, this construction has low heat storage capacity, speeds both heating and cooling. Its light weight requires less concrete foundations and steel supports.

Compare and your judgment will affirm
Petrochem-Isoflow Furnaces are Most Efficient by any Comparison

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D.D. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholtz, Los Angeles • Gordon D. Hardin, Louisville • Turbex, Philadelphia

International Licensees and Representatives: SETEA—S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentine • Promotora Nacional De Industrias, S.A., Caracas, Venezuela • Firma Dr. C. Otto & Comp. G.M.B.H., Bochum, Germany • Birwelco Ltd., Birmingham, England • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge, Liege, Belgium • Heurtey Italiana S.P.A., Milan, Italy

GENERAL REFRACTORIES

background of champions . . . . BRICK

The stands may be steel, the walls concrete, but there'd be no World's Series crowd like this were it not for brick, and you'd have no money to pay for a seat.

Brick—refractory brick—is the fundamental and universal material of industry. It stands at the beginning of manufacturing, power, transportation . . . everything that's made or moved.

Meeting these needs, with the infinite variety of their requirements, calls for massive production facilities. But even more important, it calls for the application of the most advanced and intricate physical sciences.

The first we provide with plants located from coast to coast. The latter with the world's largest and most modern refractories research laboratory.

GENERAL REFRACTORIES COMPANY
Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE PETROLEUM INDUSTRY

To maintain quality in castables, plastics, mortars, brick and the many other refractory products required by the Petroleum Industry requires just such an organization as GREFCO. First of all, proper formulation and manufacturing procedures must be developed. For this a modern laboratory with many kinds and types of modern equipment is necessary. Also experienced technicians are essential. GREFCO has the largest and most modern well equipped refractory laboratory in the world well staffed with trained and experienced technicians. A product developed by the GREFCO central research laboratory can be depended upon as being an outstanding quality product. Also, published data on products can be depended on to be accurate and reliable. No guesswork.

Modern manufacturing facilities and absolute control of raw materials are a second must for quality products. Here again GREFCO excels and has not one, two, or three manufacturing units but 26 strategically located modern works with plant or district laboratories staffed with experienced ceramic engineers who constantly check and test raw materials and production.

Why take the chance of shutting down equipment because of failure of a refractory lining. Don't let the cut price of the wood shed operation tempt you. Specify GREFCO and be assured of quality and uninterrupted service.

When you're fighting the weather as well as heat loss

Workmen applying Thermobestos insulation to an expansion loop in a process line.

Specify

J-M THERMOBESTOS® the heat insulation designed for outdoor process industries

Here's proof that rugged physical strength and high insulating efficiency can be combined in one material. J-M Thermobestos is strong and rigid, yet light enough for easy handling and fast application. It is not damaged by prolonged wetting. Its hard composition resists crushing and will withstand unusual service abuse. The low conductivity compares favorably with other accepted industrial insulations.

This unique combination of properties means excellent temperature control and minimum maintenance cost for oil refineries, chemical processing plants and other plants with outdoor vessels and hot piping.

Made from calcium hydrosilicate, Thermobestos is molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends. Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints. In pipe insulation form, it comes in a complete selection of sizes up to 24" x 3" half-sections. Also available in 6" x 36" and 12" x 36" blocks in a full range of thicknesses. For further information write to Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ontario.

JM PRODUCTS

Johns-Manville *first in* INSULATION

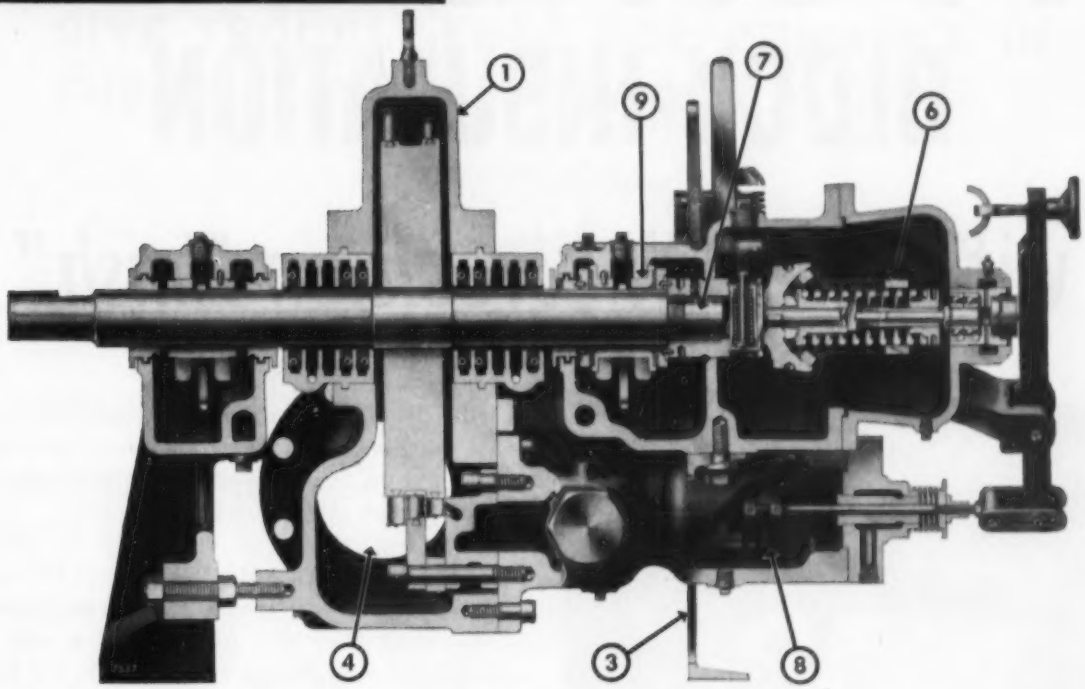
MATERIALS · ENGINEERING · APPLICATION

NEW DE LAVAL

HCB

SINGLE STAGE TURBINE

can be ordered from stock



1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is *removable* for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
Steam Pressure: 300 PSIG MAX
Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
Exhaust: 6"–150# ASA FLG.
Weight: 1,200 LB

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

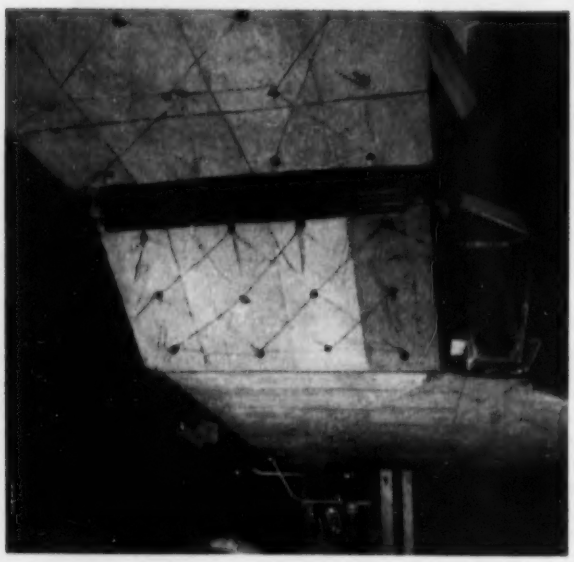
Send for new Bulletin 4206
which gives vital facts and figures

DE LAVAL *Mechanical Drive Turbines*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey.

EAGLE-PICHER
PV SUPERTEMP
BLOCK INSULATION

with the NEW *"Precision-Finish"*



A TRUE-CUT BLOCK! Eagle-Picher's new "precision-finish" is one of the most important insulation developments in years. Here's a highly efficient, all-purpose insulating block that is practically dustless.

GREAT STRUCTURAL STRENGTH! Eagle-Picher PV Supertemp Block meets your specific demands for long-lasting insulating block able to withstand a wide hot surface temperature range up to 1900 F. PV Block effectively resists steam and other moisture, does not disintegrate or lose thermal efficiency under heavy-duty service.

EASILY INSTALLED! Lightweight PV Supertemp Block is easy to handle, requires only minimum reinforcing. It is easily cut to fit irregular areas—and no special tools are needed.

WRITE FOR FREE SAMPLE TODAY!

Compare Eagle-Picher PV Supertemp Block with other insulating blocks. You'll appreciate the improved temperature control that pays off in greater fuel savings. You'll sell yourself on the new "precision-finish"!

Since 1843

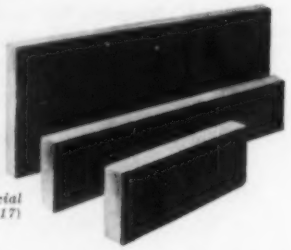
EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

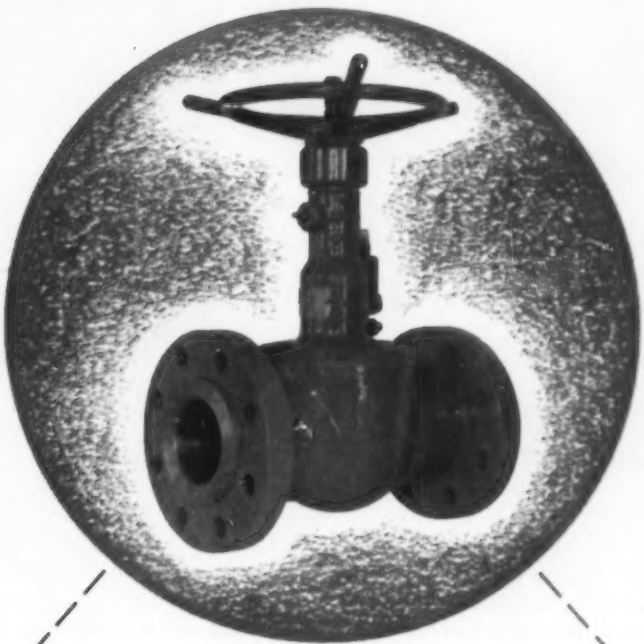


(Conforms to Commercial Standard CS 117)

FORGED STEEL

ORBIT ASA CLASS FORGED STEEL VALVES GIVE TROUBLE-FREE PERFORMANCE IN THE FOLLOWING SERVICES . . . .

1. HYDROGEN
2. AMMONIA (Liquid or Gas)



3. HYDROCARBONS (Liquid or Gas)
4. BUTADIENE

WELDED BONNET CONSTRUCTION

RISING STEM

No Lubricant Required for Tight Shut-off.

This feature is important on hydrogen lines of platforming units where contamination carry-over from valve lubricants can lower catalyst efficiency.

Available in both Carbon and Stainless trim: Full Round Opening in sizes 1" to 4" Flanged and Screw End. Venturi Opening; Flanged only, sizes 2" to 6".

See 22nd Edition of Refinery Catalog or write for Catalog 55-B.

ORBIT VALVES®

ORBIT VALVE COMPANY

P. O. BOX 699 *(For over 40 years)* TULSA 1, OKLAHOMA

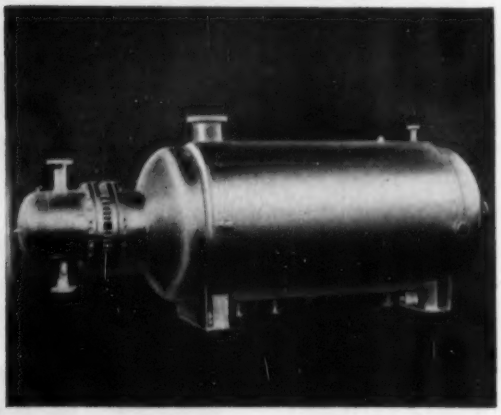
For more data on advertised products, use Readers' Service Cards, last page.

ECONOMY
High-alloy layer—usually 10% or 20% of total plate thickness—assures corrosion and abrasion resistance, long equipment life.

DESIGN FREEDOM
Integral bond allows design and fabrication of shapes to meet process and space needs.

STRUCTURAL STABILITY
Low-cost carbon steel backing provides necessary strength and rigidity.

Nickel-clad steel gives this jacketed heating unit high corrosion resistance in processing light hydrocarbons and dilute hydrochloric acid.



CLAD STEEL EQUIPMENT PERMITS

FULL DESIGN FREEDOM

When new equipment is being planned, economical clad steels will assure maximum design freedom for your tanks and pressure vessels. Because of the integral bond between high-alloy cladding and the carbon steel backing plate, full gage consideration is permissible under the API-ASME Code. Clad can be readily worked by conventional fabricating tools and methods, permits easy and economical field erection. In service, clad steel helps protect against unscheduled shut downs stemming from seepage or crevice corrosion.

Clad steels offer you all the corrosion resistance of solid, high-alloy construction with savings up to 50% in material costs. These and other benefits, easy cleaning, drainage inspection or modification, can be obtained from 16 cladding materials—various types of stainless, nickel, Inconel, Monel, copper.

These are supplied with a standard sodium hydride finish, or may be polished to help improve performance characteristics. When you're thinking of new tanks and vessels, qualified equipment builders can help your engineers and consultants take advantage of versatile Lukens' Clad Steels. We work closely with fabricators to help select the type most suited to your processing needs. To get more information, ask one of your equipment builders, or write Manager, Marketing Service, Lukens Steel Company, 751 Lukens Building, Coatesville, Pennsylvania.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

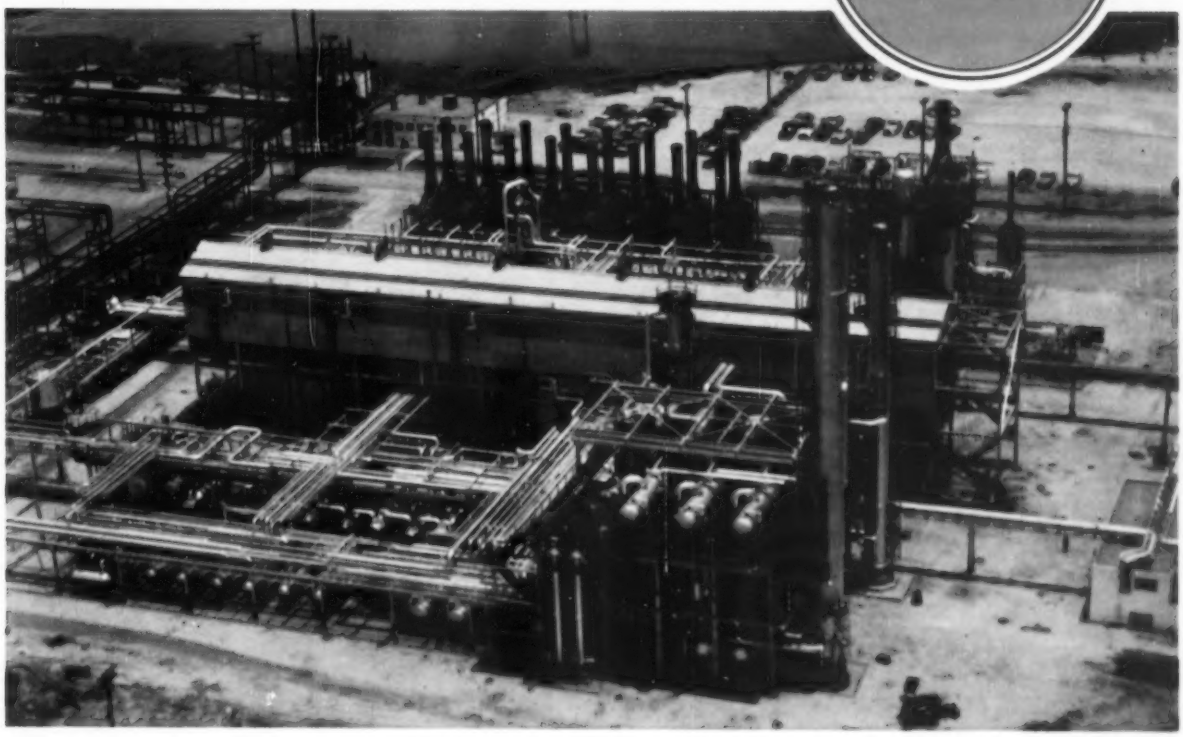
PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

For more data on advertised products, use Readers' Service Cards, last page.

ETHYLENE PRODUCTION:

PERFORMANCE IS THE PAYOFF

GULF



Gulf Oil Corporation's new No. 2 Ethylene Plant at Port Arthur, Texas, designed and constructed by Stone & Webster Engineering Corporation, proves again that — in *any* plant — performance is the payoff.

Stone & Webster's pyrolytic cracking process, commercially proven on feedstocks ranging from light hydrocarbons to heavy gas oils, is used in the Gulf plant designed to produce ethylene from ethane and propane.

Stone & Webster's ethylene recovery and purification processes are selected on the basis of plant experience with four basic ethylene recovery techniques. In the Gulf plant a low temperature fractionation process having many unique features was chosen to provide ease of operation with high product purity and recovery from a mixed refinery pyrolysis-gas feed.

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

GOING PLACES *in the roaring jets with Cities Service...*

The gargantuan, ever-growing thirst of the military jet planes was slaked last year by 124,000,000 gallons of Cities Service jet fuels. Cities Service refineries are geared to provide increasing quantities of vital defense matériel.

CITIES SERVICE

A Growth Company

Number 13 of a series

KUPLEX

the new Tretolite metal deactivator

Kuplex deactivates harmful copper and copper compounds by a chelating action. This prevents hydrocarbon deterioration caused by metal catalyzed oxidation. Kuplex prevents the undesirable reactions by combining with the dissolved copper to form a stable chelate. If copper is present, the use of Kuplex will reduce the amount of anti-oxidant necessary to effect desired stability.

Kuplex can be effectively used to deactivate copper in hydrocarbons such as

GASOLINE • KEROSINE
JET FUEL • DIESEL OIL
FURNACE OIL • TURBINE OIL

Kuplex effectively protects the quality of hydrocarbon products for as little as 2 mills per barrel. This insurance against customer dissatisfaction is worth many times its low cost.

For complete technical data, samples and prices, ask your Tretolite refinery service engineer or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

chemicals and services for the petroleum industry

Desalting • Demulsifying • Corrosion Preventives • Scale Inhibiting Asphalt Additives • Fuel Oil Additives • Water De-oiling • Paraffin Removal • Production Stimulation • Bactericides • Metal Conditioners

For more data on advertised products, use Readers' Service Cards, last page.

ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

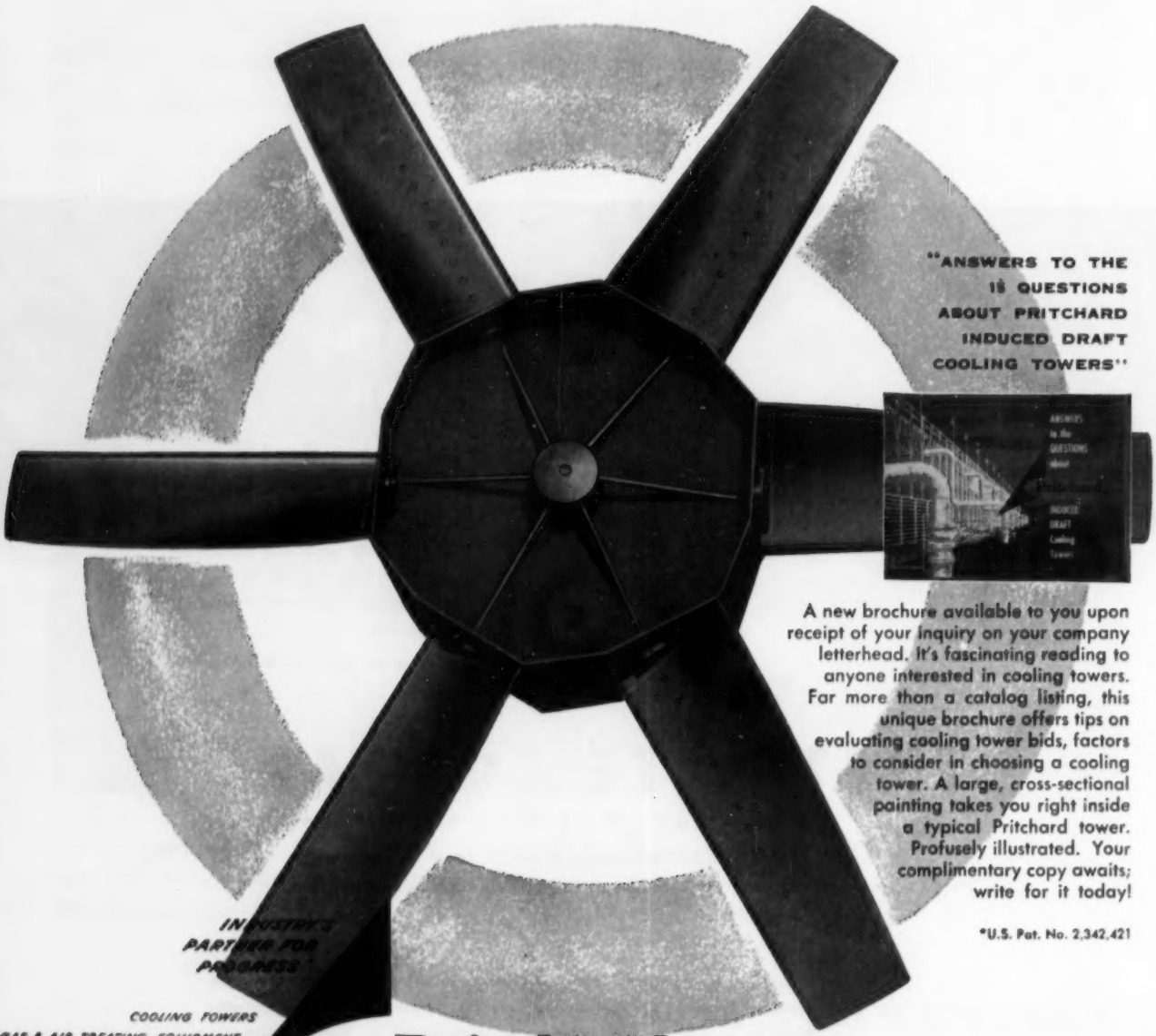
RUGGED *POWairSAVER** FAN DEVELOPS MAXIMUM AIR FLOW ECONOMICALLY

The POWairSAVER fan is exclusive with Pritchard. It was developed specifically for cooling tower service. It develops maximum air flow, economically, because of patented* design and construction.

The blade, of airfoil design, is twisted to pump as much air at the hub as at the tip of the blade. The hub is constructed to allow for no back flow of air near the hub. Thus, you get high aerodynamic efficiency, with low horsepower, on this adjustable pitch, POWairSAVER fan, exclusive with Pritchard!

POWairSAVER blades and hubs are precision-made in jigs for greater uniformity and easy interchange of parts. Monel or stainless steel blades are available to meet specific anti-corrosion requirements.

A six-blade design is pictured. Also available in four and eight-blades. It's exclusive with Pritchard—the POWairSAVER fan—one more reason to choose Pritchard cooling towers!



"ANSWERS TO THE 18 QUESTIONS ABOUT PRITCHARD INDUCED DRAFT COOLING TOWERS"

A new brochure available to you upon receipt of your inquiry on your company letterhead. It's fascinating reading to anyone interested in cooling towers. Far more than a catalog listing, this unique brochure offers tips on evaluating cooling tower bids, factors to consider in choosing a cooling tower. A large, cross-sectional painting takes you right inside a typical Pritchard tower. Profusely illustrated. Your complimentary copy awaits; write for it today!

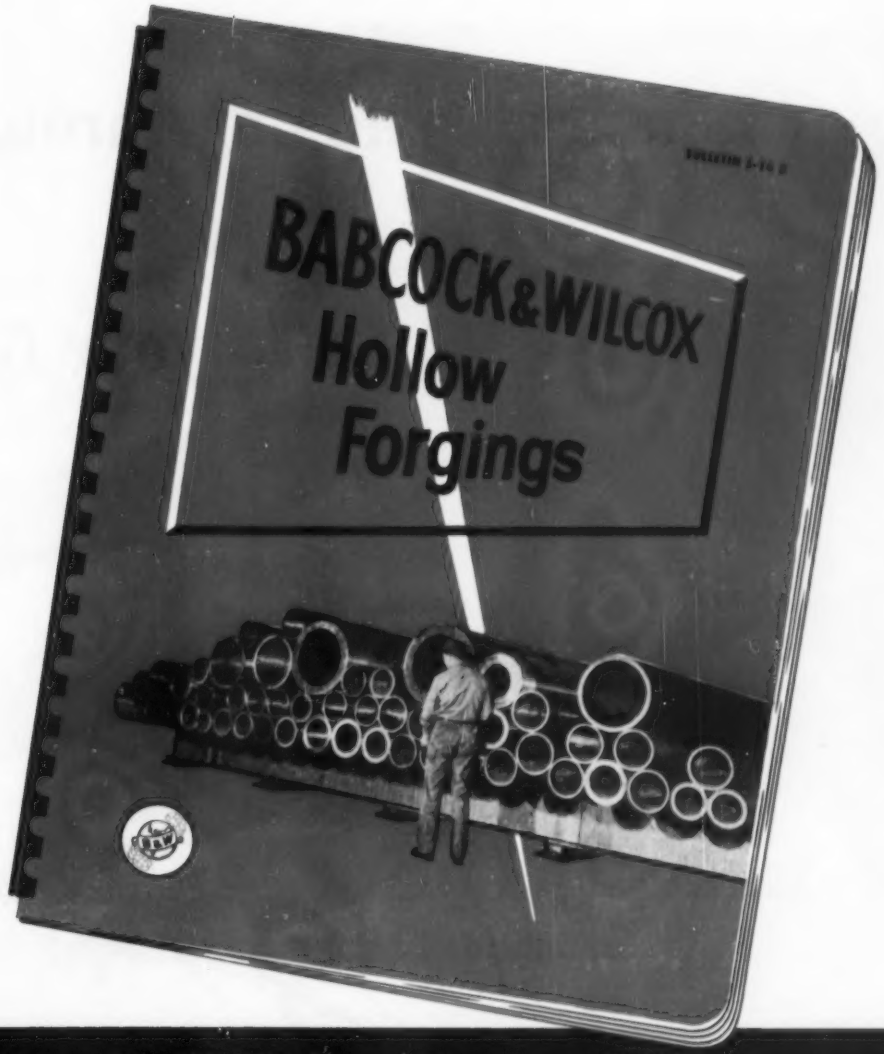
*U.S. Pat. No. 2,342,421

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 444, 4625 Roanoke Parkway, Kansas City 12, Mo.



This New B&W Hollow Forgings Bulletin ...gives comprehensive data on an unusual subject

Fully detailed, with charts, photographs, tables and text, this just-published bulletin provides a broad coverage of what, very often, is both an engineering and procurement problem.

Its contents include:

- **Specifications**
- **Materials Reference Table**
- **The Hollow-Forging Manufacturing Process in Pictures**
- **Photomicrographs of Castings and Forgings**
- **Sizes — Carbon, Intermediate Croloys and Austenitic Stainless**
- **Analyses of Standard Hollow-Forgings Alloys**

For ready and complete Hollow Forgings reference, send for Bulletin S-16B to The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX
BOILER DIVISION

S-444

For more data on advertised products, use Readers' Service Cards, last page.

are man-hours slipping through your fingers?

P-A-X Business Telephone Systems cut this loss

These are some of the companies saving man-hours with one or more P-A-X Business Telephone Systems!

Atlantic Refining Company, since 1923, 1,642 telephones.
Cities Service Oil Company, since 1914, 222 telephones.
Humble Oil and Refining Company, since 1929, 1,525 telephones.
Phillips Petroleum Company, since 1939, 447 telephones.
Shell Oil Company, since 1919, 2,400 telephones.
Union Oil Company of California, since 1941, 1,555 telephones.

When your people have to walk about to exchange information, they're wasting time—through no fault of their own! What you need is a P-A-X Business Telephone System, providing "touch-of-a-dial" communication to the office next door—or 'way in the next division!

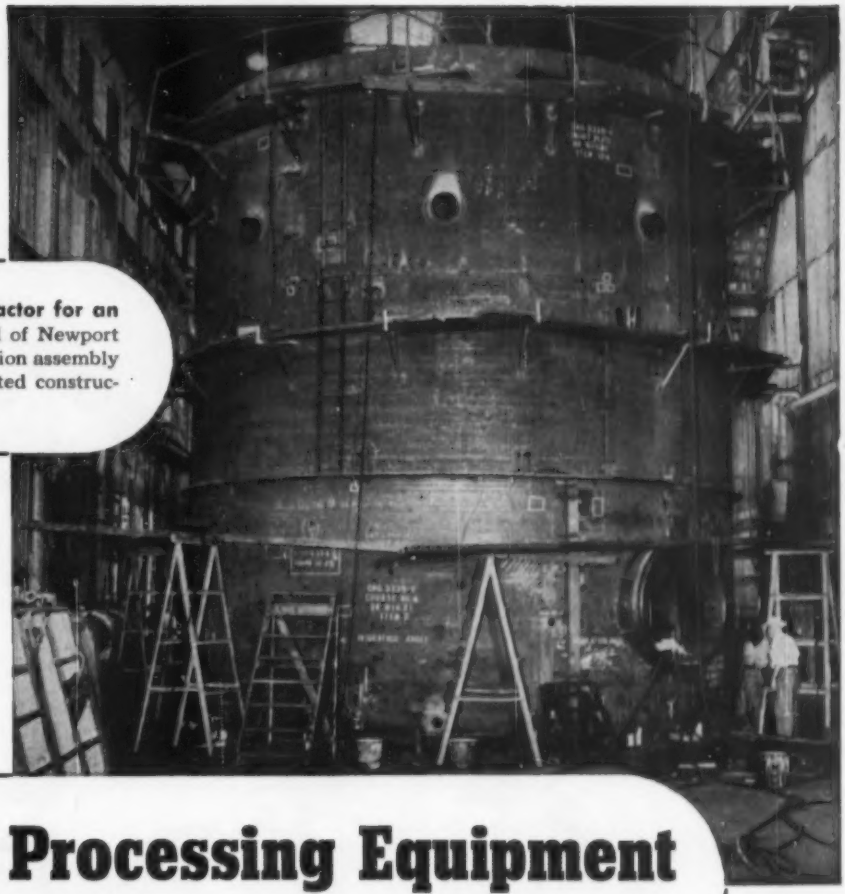
Through the P-A-X System, each person can reach anyone else—in seconds. Overall supervision is made easier, and all departments can coordinate their activities for top efficiency. That's why many railroads depend on P-A-X for lightning-fast communication throughout the length and breadth of their widespread operations.

Rent-free P-A-X is railroad-owned and controlled; your own communications men install and move P-A-X telephones as you wish. It is rent-free, entirely separate from the public telephone system, and uses railroad-owned or leased lines.

Discover how other railroads are saving time and money, increasing efficiency, with a P-A-X Business Telephone System. For an actual "on-the-job" case study, *write:* Automatic Electric Sales Corporation (HAymarket 1-4300), 1033 West Van Buren Street, Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC

ORIGINATORS OF THE AUTOMATIC DIAL TELEPHONE



Course number four of a reactor for an overseas oil refinery. Typical of Newport News plant methods, the precision assembly of this unit in the shop expedited construction of the reactor in the field.

Petroleum Processing Equipment

...Built by Specialists in Metal Fabrication

Careful attention to detail characterizes the work of Newport News craftsmen...

They've fabricated millions of tons of steel including corrosion-resistant alloy, clad and other special steels for many diverse industries.

Newport News handles the job exactly as you want it done, for maximum results per dollar invested.

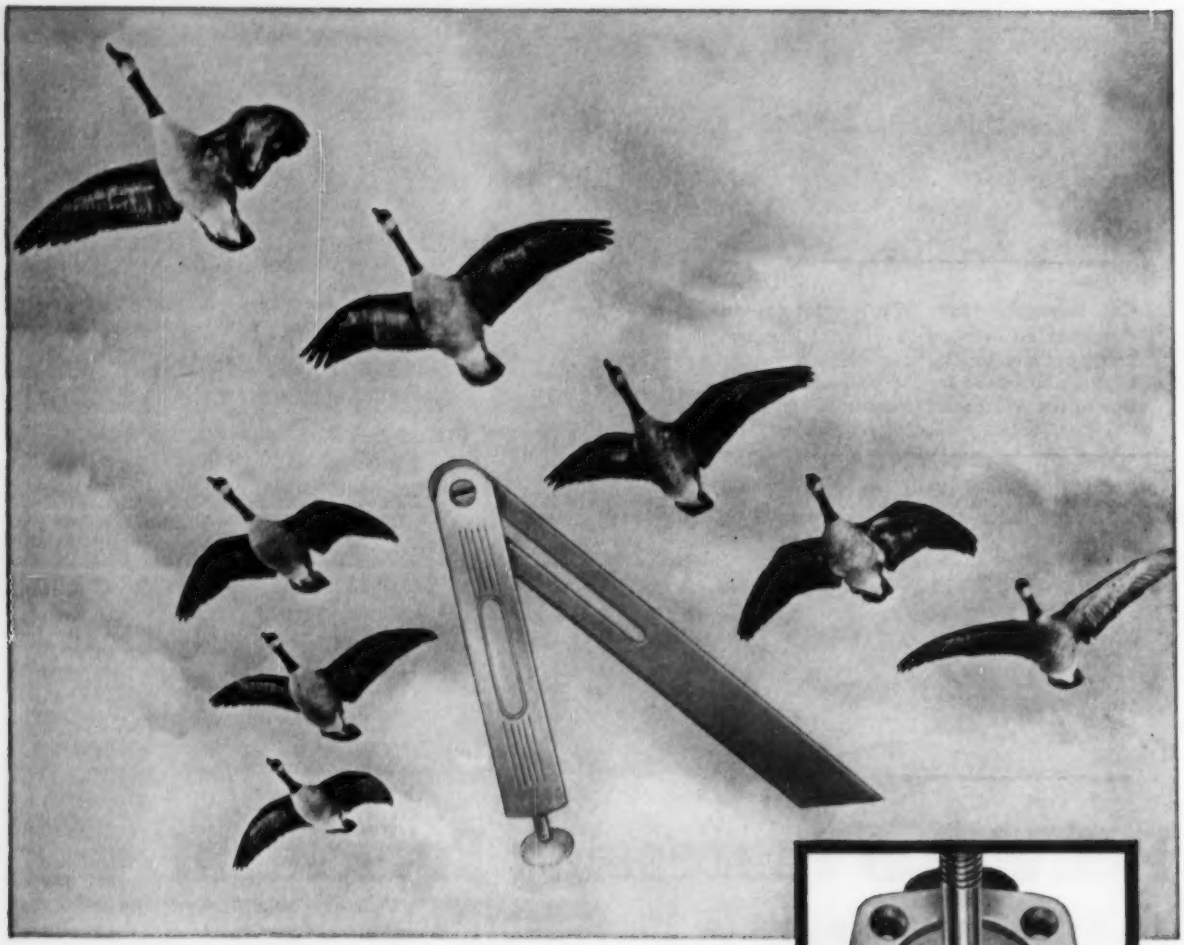
Specialized production techniques, advanced plant methods and a complete range of facilities along with many special purpose machines contribute to the excellence of Newport News fabrication.

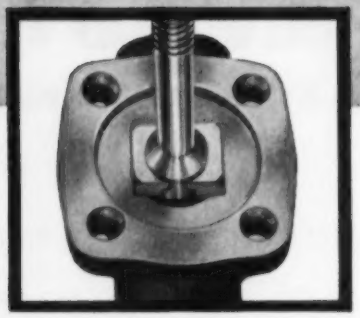
Let us bid on equipment for your present or future projects. Learn how Newport News can help you...send for our booklet entitled "Facilities and Products." It's yours for the asking.

Newport News Shipbuilding and Dry Dock Company

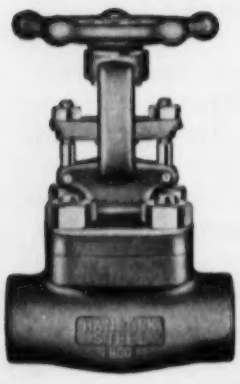
Newport News, Virginia

For more data on advertised products, use Readers' Service Cards, last page.





GUIDE-ABILITY
that means longer life



FULL GUIDING in the Type 950 Hancock Steel Gate Valve does not permit the wedge to gall, scuff, chip or wear the seating surfaces. Four accurately-machined grooves in the valve body guide the wedge to and from the seats and prevent wedge rotation. No matter how great the flow and pressure load or the rotating force exerted by turning the handwheel, the wedge corners do not hit or rub across the seating surfaces. This close-clearance guiding protects against seat damage that frequently causes other valves to leak in as few as one opening-and-closing operation at service pressures.

The provision for precise *full guiding* adheres to the principle that valve seats and wedges *should wear from long service, not from battering against each other.* It is one of many quality features that keep Type 950 Hancock Steel Gate Valves in the line longer. Your Industrial Supply Distributor will gladly demonstrate. Phone him today.

HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

LARKIN
FORGED
STEEL
BULL PLUG

LARKIN
HEXAGONAL
BULL PLUG

FITTINGS of the Highest Quality

LARKIN
FORGED
STEEL
SWAGED
NIPPLE

LARKIN
HEXAGONAL
SWAGED
NIPPLE

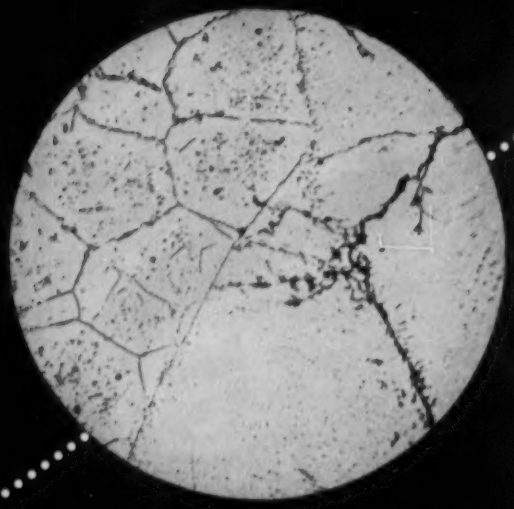
Before any Larkin Fitting leaves our plant, it has undergone more than 16 separate manufacturing and inspection operations. After forging, Larkin Fittings receive careful descaling, threading, chamfering, beveling, coating, labeling and packaging. In between each operation is a step-by-step inspection. And there are no short-cuts. That's why you can be sure that every Larkin Fitting is highest quality . . . the best that modern manufacturing and careful workmanship can produce. Specify Larkin through your supply store.

LARKIN
...Through Your Supply Store

LARKIN PACKER COMPANY, INC. • ST. LOUIS, MO.

Hexagonal Swages and Bull Plugs . External Upset Swages and Sub-Tubing Nipples . Refinery Swaged Nipples and Bull Plugs
Seamless Casing Nipples . Seamless Tubing Nipples . Steel Tubing Couplings . Substitute Couplings
Sub-Tubing Nipples and Pup Joints . Perforated Tubing Nipples . Adaptor Nipples . Boiler Nipples . Choke Nipples

Here's a better solution to a tough Corrosion Problem



Carpenter 7Mo Stainless Tubing & Pipe

The corrosion-inviting cracks in the right-hand section of the photomicrograph above end abruptly as they near the center of the picture... and that quick ending may help you find a quick ending to stress corrosion cracking problems.

The picture is Carpenter 7Mo stainless pipe (left) welded to a Type 316 fitting. It is still unaffected by the stress corrosion cracking that has destroyed the usefulness of the fitting. The pipe outlasted three such fittings before the photomicrograph was made.

The stout resistance of Carpenter 7Mo to stress corrosion cracking, even in the presence of chlorides or other caustic and sulphite solutions, is coupled with excellent resistance to general corrosion and pitting. It has been used as a "problem solver" in food and chemical processing plants, pulp mills, petroleum refineries and other places. There may be a profitable place for it in your operation. We'll be glad to work with you, aid you in investigation of your problems and a possible 7Mo solution.

MEMBER

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Write for your copy of the Carpenter 7Mo Technical Bulletin containing comprehensive data.

Carpenter

Stainless Tubing & Pipe

NEUTRAL
NONREACTIVE
HIGHLY REFRACTORY

Alcoa Tabular Alumina Balls

for CATALYST, REACTOR,
DESICCANT BED SUPPORTS AND COVERS

ALCOA Tabular Alumina Balls T-162 in ¼-inch, ⅜-inch, ½-inch and ¾-inch diameters are used as desiccant and catalyst bed supports or covers where exposed to high temperature, severe corrosive or erosive conditions. High chemical purity and inertness make contamination negligible.

ALCOA Tabular Alumina Balls T-164 available in ¼-inch and ⅜-inch diameters are more resistant to thermal and mechanical shock. They are suitable for pebble heaters and similar severe operations requiring high heat capacity and conductivity.

For additional information and samples, write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-K Alcoa Building, Pittsburgh 19, Pennsylvania.

PROPERTIES OF TABULAR ALUMINA BALLS

Chemical Analysis
Al_2O_3 ..... 99.5+%
Mean Specific Heat (Btu/lb/°F)
74°F to 212°F 0.200
74°F to 932°F 0.233
74°F to 1832°F 0.244

BALL SIZES AND WEIGHTS

Nominal size, inch	Passes screen opening, inch	Retained on screen opening, inch	Approximate	
			Balls per pound	Pounds per cu ft
¼	0.371	0.263	670	128
⅜	0.525	0.371	202	126
½	0.624	0.525	72	125
¾	0.883	0.742	27	125

ALCOA Tabular Alumina Balls are high purity alumina (sintered corundum). Produced at temperatures above 3000°F, these balls have a softening point well above 3500°F. Unaffected by both oxidizing and reducing atmospheres at temperatures below the softening point, they are practically insoluble in all aqueous acid and alkaline solutions.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

For more data on advertised products, use Readers' Service Cards, last page.

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.

3,000- to 4,000-gallon glassed reactors now offered in low-cost *standard* designs

Smashing the size barrier, The Pfaudler Co. now fabricates glassed steel reaction kettles in the 3,000- to 4,000-gallon range – as *standard* models.

This use of standard designs saves you money because it eliminates special engineering. And it saves time because it uses stock parts and standard accessories.

Of course, where your requirements are of a special nature, special refinements are available, as well as entirely custom-engineered reactors up to 7,500 gallons.

Space-saving drive support

Drive is rigidly supported on a separable center cover, making other top head openings easily accessible and leaving plenty of space for all nozzles usually required.

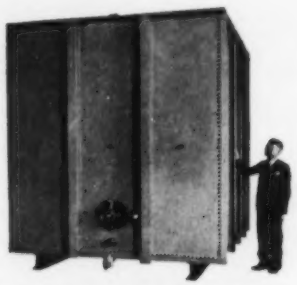
Nine openings—various sizes

You get the full advantage of versatile glassed steel because the top head is equipped with nine nozzles, in several sizes, to facilitate adapting the unit to a wide variety of processes.

Other advantages

Offset bottom outlet, efficient jacket provides clean-out ports. Pfaudler agitating nozzles and many other plus values are available in these new standard model reactors. Your Pfaudler representative has all the facts. Write or call him.

This glassed steel reactor at Schenectady Varnish Co. incorporates these new standard features. Note its compact drive support, leaving ample head space for other equipment. Left of drive is a glassed steel column, 18" dia., for calcium chloride; right foreground is 14" glassed steel hopper for adding catalyst.



Pfaudler rectangular tanks make full use of every square foot of available floor space.

Endless variety of storage problems solved with glassed steel

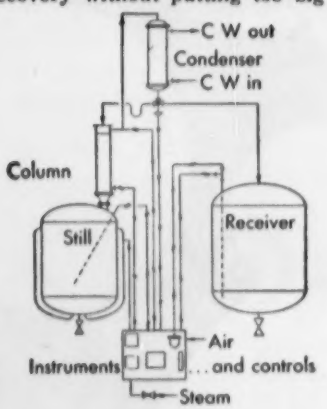
You can make efficient use of floor space with one of the many Pfaudler glassed steel tank designs up to 35,000 gallons; cylindrical tanks (horizontal or vertical), rectangular tanks that utilize every inch of floor area and head room, and square panel vats that can be assembled on the spot.

The smooth surface of Pfaudler tanks is extremely easy to clean because almost nothing sticks to glass, besides being corrosion resistant.

The glass-to-steel bond is actually a *chemical* union of the two materials – so strong that in tests a force of 1,500 lbs. per sq. in. was unable to separate them. Thus you need not fear any peeling off of the inner lining. Thus you are able to handle liquids and solvents through a wider temperature range than with other types of lined tanks.

New fractionating assembly is small but highly effective

Here is a small fractionation assembly, in "packaged" form, that can easily put you on the road to solvent recovery without putting too big a crimp in your budget.



SMALL FRACTIONATION SYSTEM IS DELIVERED COMPLETE WITH CONTROLS

It makes use of a glassed steel still and column, to provide maximum corrosion resistance where there is acid present in the batch. This makes the assembly highly practical for such materials as methanol, ethanol, acetone, and ethylene dichloride.

Because the acid remains in the still, the condenser is fabricated from type 316 stainless steel. A glassed steel vacuum receiver is provided for maximum service life, versatility and product purity.

With this assembly, Pfaudler can actually give you a *guarantee* of performance for a specific separation. For example, if you wanted to recover 90% methanol from a charge containing 50% methanol, simple distillation would produce, at best, 65% recovery in a concentration of 60%, and your product would be subject to a certain amount of contamination. To remedy this, Pfaudler is able to guarantee recovery of over 95% of the methanol in the charge, in a concentration of at least 90%, and essentially acid-free.

Low cost is another important advantage of this system. By providing a standard "packaged" assembly, Pfaudler has been able to eliminate most engineering charges involved in developing an assembly especially for your specific operation.

Your Pfaudler representative can answer your specific questions. Call or write him.

For further information on standard glassed reactors, packaged fractionating assembly, or storage vessels, write to Department PR-10, The Pfaudler Co., Rochester 3, N. Y.

Hard-boiled acids can't corrode Aloyco "Hastelloy" Valves

The fight against corrosion by hot mineral acid solutions is being won by the Hastelloys.

This family of alloys plays a major role in the production of Aloyco corrosion-resistant valves. And here's why:

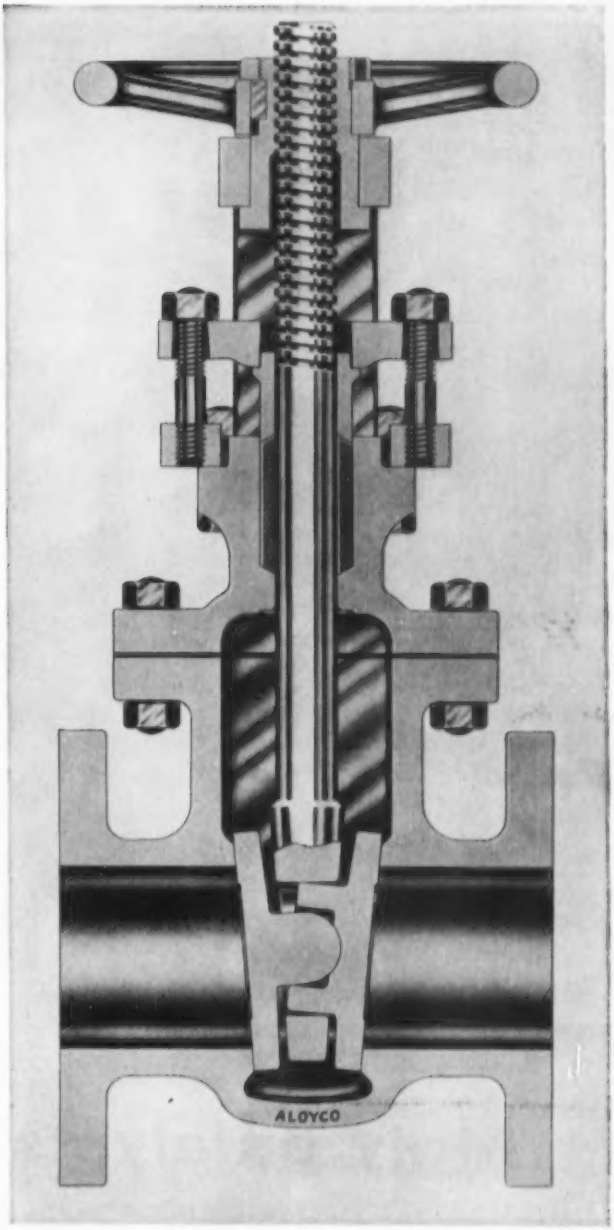
Hastelloy Alloy B is the only available alloy, with the exception of noble metals, that resists hydrochloric acid in all concentrations—even at boiling temperatures. It also withstands corrosion by hot sulfuric acid concentrations where other materials have been found unsatisfactory.

Hastelloy Alloy C at room temperature has good resistance to wet chlorine gas, hypochlorites and other solutions containing chlorine. It is also outstanding for its resistance to secondary spin bath solutions encountered in the rayon industry.

Hastelloy Alloy D has excellent resistance to sulfuric acid at high concentrations and elevated temperatures. It outperforms all other materials in resisting sulfuric acid solutions containing hydrocarbons, coke and tar encountered in oil refineries.

This remarkable Hastelloy family is now available in a wide range of Aloyco valve designs. Cast by induction melting of master heat ingots, Hastelloy valves undergo a special annealing process that imparts better machining qualities . . . assures maximum corrosion resistance. A new bulletin, couponed below, will provide you with complete information.

Write today to: Alloy Steel Products, Inc., Linden, N. J.



Aloyco Hastelloy Valves are suited by composition and a special annealing process to handle hot solutions of mineral acids.

Alloy Steel Products Company, Inc.
1303 West Elizabeth Avenue
Linden, New Jersey

Gentlemen:

Please send me a free copy of your new Bulletin No. 10 on Aloyco Hastelloy valves.

Name_____

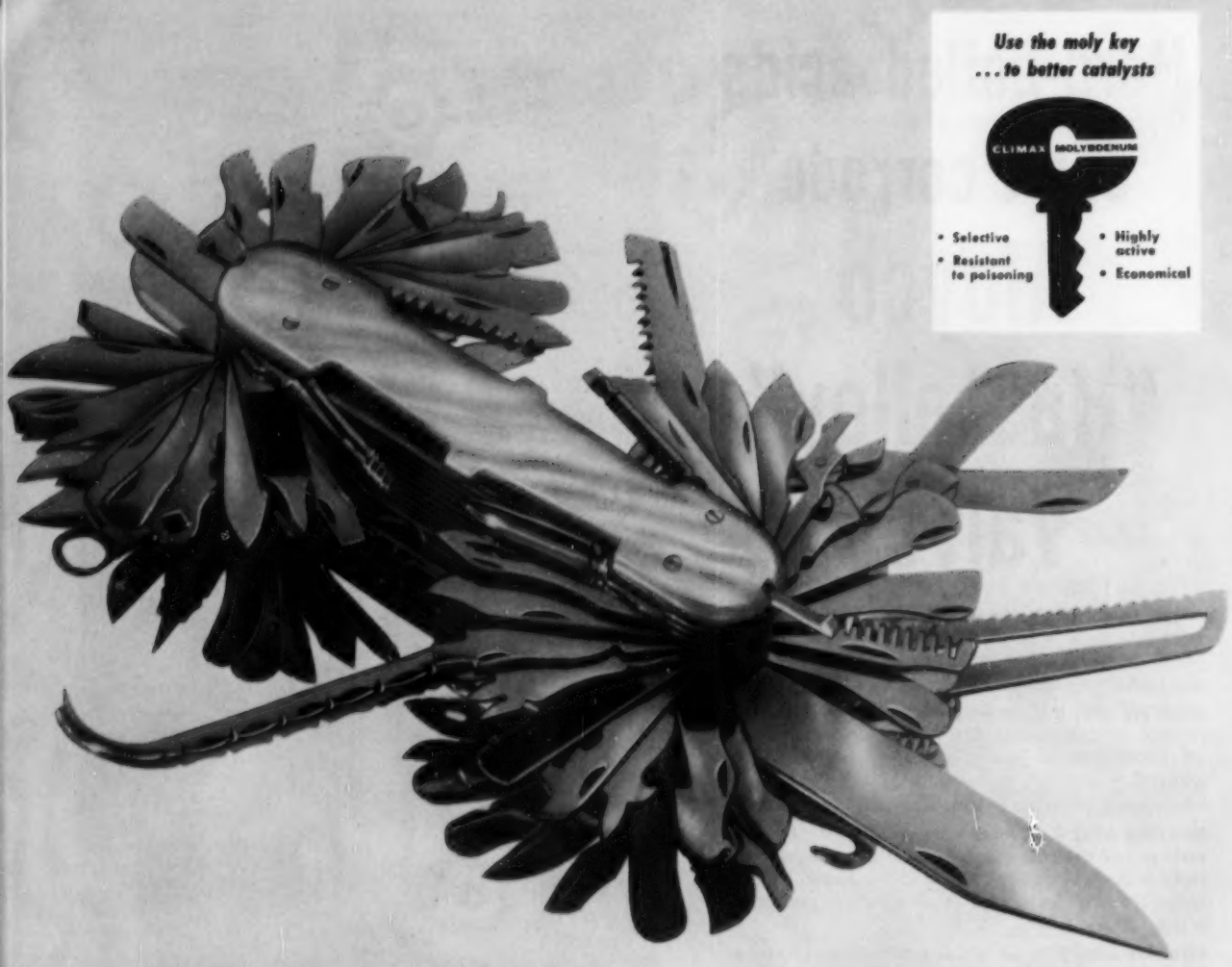
Firm_____

Address_____

City_____ Zone____ State_____

5.15

For more data on advertised products, use Readers' Service Cards, last page.



Moly catalysts are versatile

Because of its versatility, molybdenum is one of the most widely used catalytic elements. As a transition element, it has the incomplete inner shell of electrons needed for catalytic activity. Ease of transition from one to another of its six valence states allows it to function readily as an electron acceptor or donor. It forms a variety of compounds in all valence states, most of them resistant to common catalytic poisons. Commercially, molybdenum catalysts are used in seven types of reactions: oxidation, hydrogenation, dehydrogenation, isomerization, cyclization, chlorination and condensation. Promising results have been obtained in dehydration, polymerization and alkylation. For complete data write Department 25, Climax Molybdenum Company, 500 Fifth Ave., New York 36, N. Y. for our bulletin, "Molybdenum Catalysts for Industrial Applications."

CLIMAX MOLYBDENUM

Courtesy of Hoffritz for Cutlery, 331 Madison Avenue, New York

NEW H-5

1/2-YD., 9-TON

BUCYRUS-ERIE COMPANY
South Milwaukee, Wisconsin

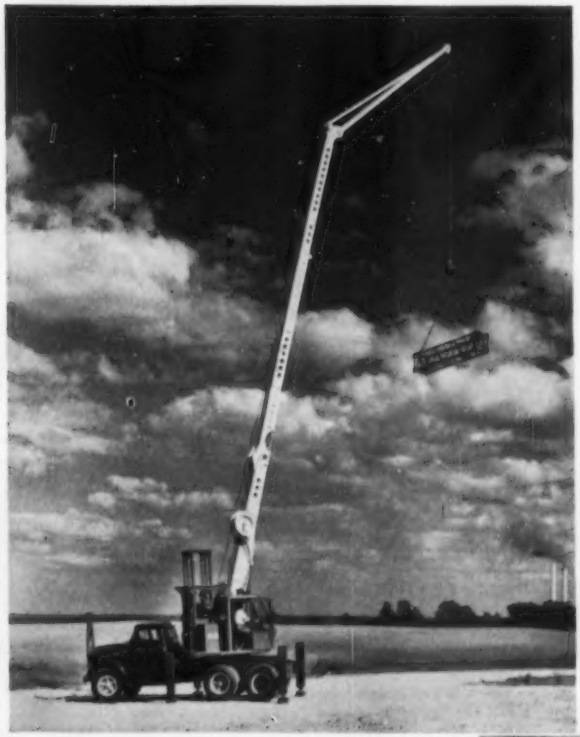
Gentlemen:
Send me your new H-5 Bulletin. This crane interests me for _____ work.
(type of job)

Name _____
Company _____
Title _____
Address _____
City _____ State _____

91H55

Hydrocrane Mounts on Conventional Truck

Completely new from outrigger feet to boom tip, this powerful 9-ton, ½-yd. Hydrocrane brings you work ability of heavy carrier-mounted cranes at small crane cost. Patented hydraulic outriggers permit mounting crane-excavator on a commercial motor truck, new or used, without sacrificing any basic crane working capacity.



Check these outstanding advantages—

Unmatched precision control of loads.

High-lift, three-piece boom (extra equipment at added cost) gives you 50 feet of reach, retracts hydraulically to 25 feet for travel. Boom and hydraulic fittings can be connected and machine working in less than ten minutes after arrival at job site.

12-ft. telescoping boom action — from 24 feet to 36 feet for standard two-piece boom, from 38 feet to 50 feet for high-lift boom, plus 20-ft. jib extension.

50 mph top highway speed.

Every work function fully hydraulic.

Up to 240-fpm line speed.

Available with clamshell, crane hook, magnet.

Optional remote truck control from crane cab.

Meets highway laws for over-all length and axle loads (depending on truck selection).

See it in action

Find out what the new H-5 Hydrocrane can do for you. Ask your Bucyrus-Erie distributor for a demonstration.

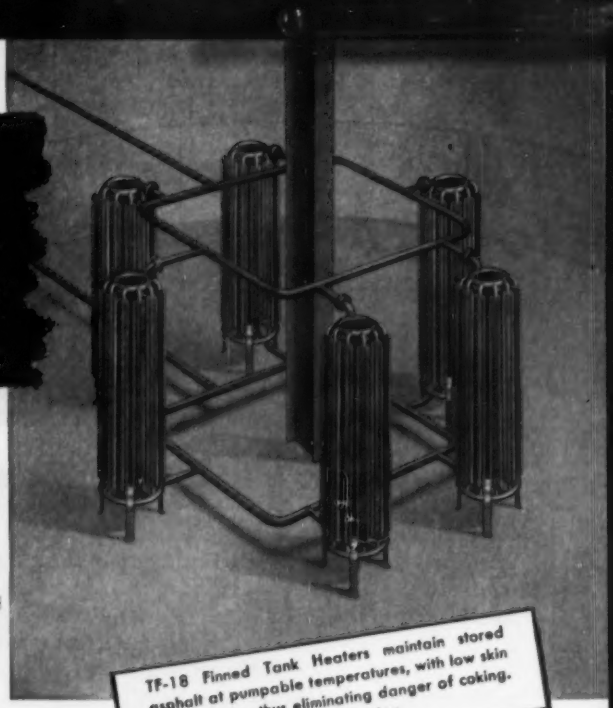
BUCYRUS-ERIE COMPANY
1880 South Milwaukee, Wisconsin **1955**
75 Years of Service to Men Who Shape the Earth

New truck, inexpensive used truck, a truck you now own — the new H-5 Hydrocrane can be mounted on any standard commercial truck you choose.

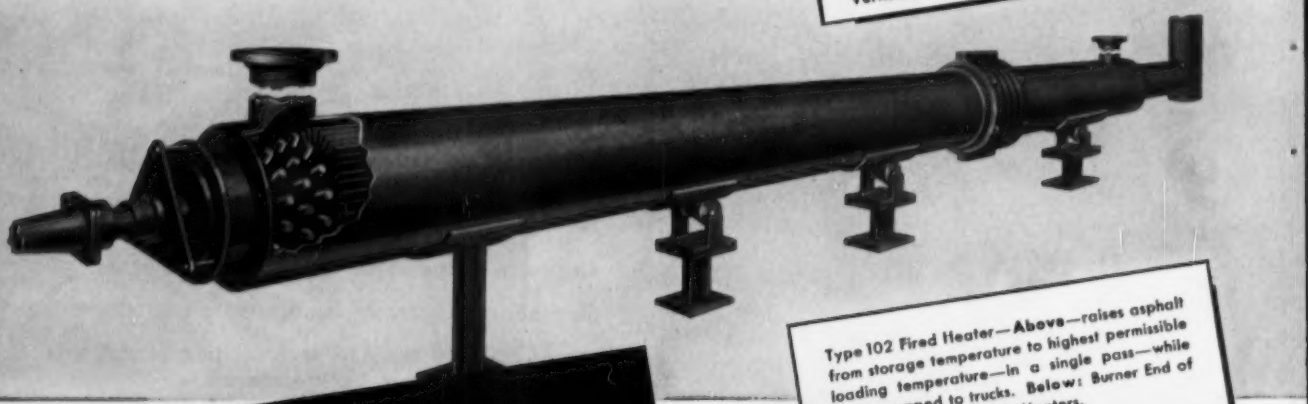
For more data on advertised products, use Readers' Service Cards, last page.

Asphalt Plants

load out faster
at higher temperatures...
serve a wider area...



TF-18 Finned Tank Heaters maintain stored asphalt at pumpable temperatures, with low skin temperatures, thus eliminating danger of coking. Vertically mounted. Self cleaning.



Type 102 Fired Heater—**Above**—raises asphalt from storage temperature to highest permissible loading temperature—in a single pass—while being pumped to trucks. **Below:** Burner End of Four Oil Fired Asphalt Heaters.

with Brown Fintube

TF 18 Tank Heaters and Type 102 Fired Heaters

BROWN FINTUBE COMPANY

Elyria, Ohio

Engineering and Sales Representatives in the Principal Cities

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

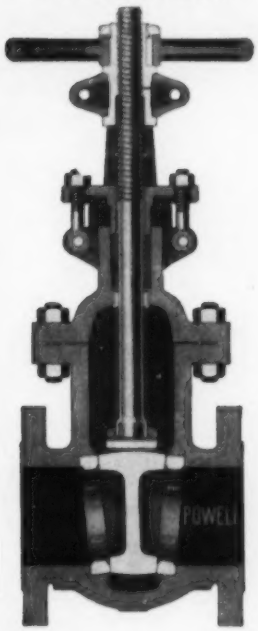


FIG. 1503 (Sectional)—
150-Pound Steel Gate Valve.

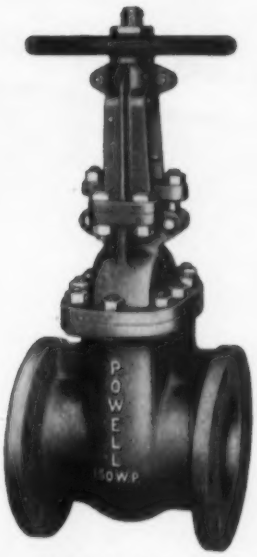


FIG. 2453-G—Stainless
Steel O.S. & Y. Gate Valve
For 150 Pounds.

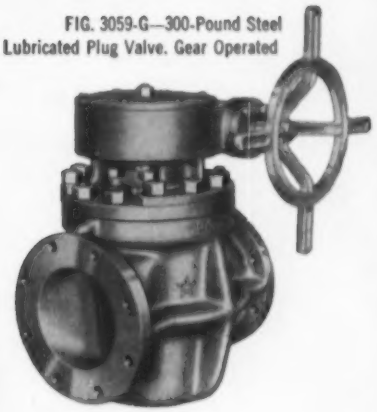


FIG. 3059-G—300-Pound Steel
Lubricated Plug Valve. Gear Operated

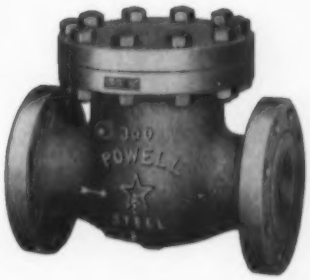


FIG. 3061—300-Pound
Steel Swing Check Valve.

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

THE COMPLETE QUALITY LINE ... POWELL VALVES ... THE COMPLETE QUALITY LINE ...

Why Petroleum Engineers Specify Powell Valves . . .

. . . . *because they know Powell Valves are dependable and economical.* Petroleum engineers also know that Powell has *the COMPLETE quality line of valves.*

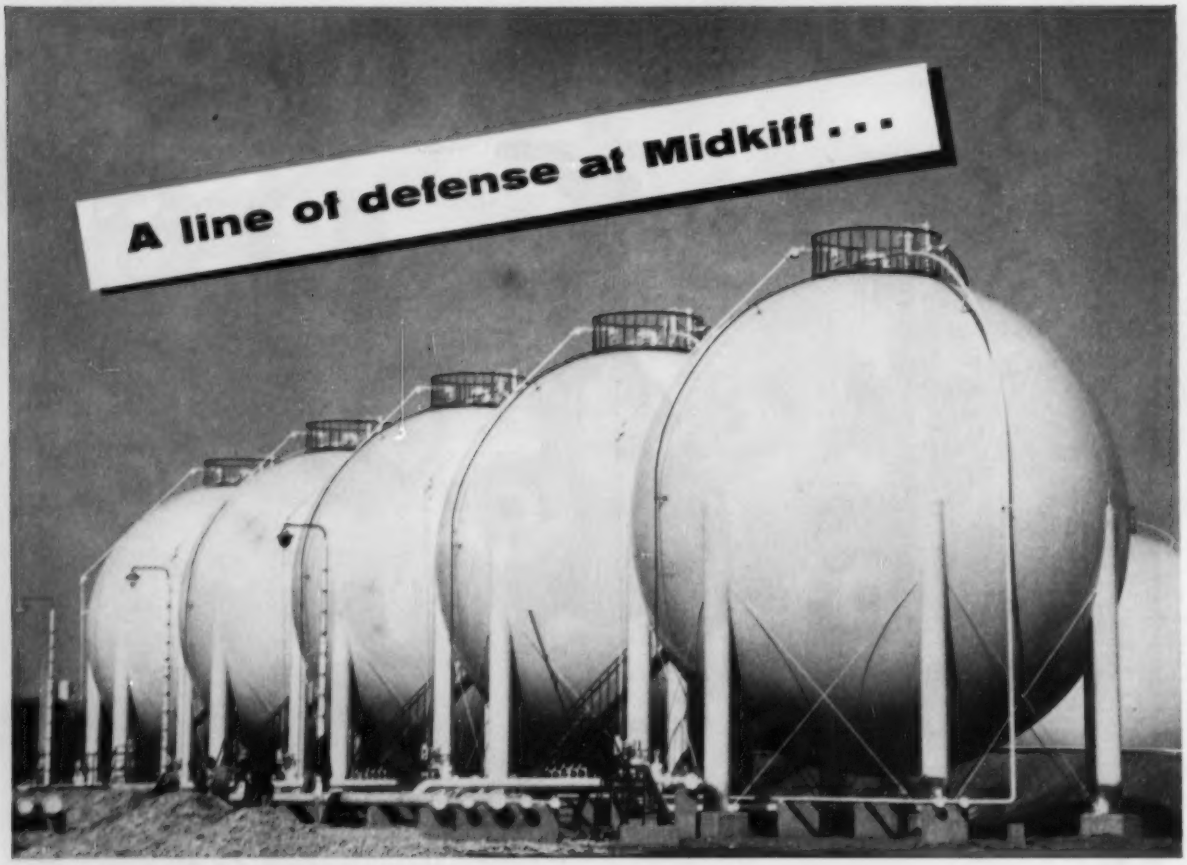
Investigate the many outstanding features of the Powell Valves shown here . . . as well as *the complete line* of quality valves that have a proven record of long life and dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio ..... 109th year

POWELL VALVES

For more data on advertised products, use Readers' Service Cards, last page.



Five Hortonspheres used for the storage of Butane

If *you* store or handle butane, you must take measures to prevent it from disappearing into the atmosphere. The 5,000-bbl. Hortonspheres® shown above, designed for 100 lbs. per sq. in. working pressure, are a reliable line of defense at the El Paso Natural Gas Company's Midkiff plant near Rankin, Texas. Vapor cannot escape as long as the internal pressure does not exceed the settings of the pressure relief valves.

Hortonspheres are built in capacities to 30,000 bbls. and for pressure to 217 lbs. per sq. in. in the smaller sizes. Write our nearest office for further information.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

For more data on advertised products, use Readers' Service Cards, last page.

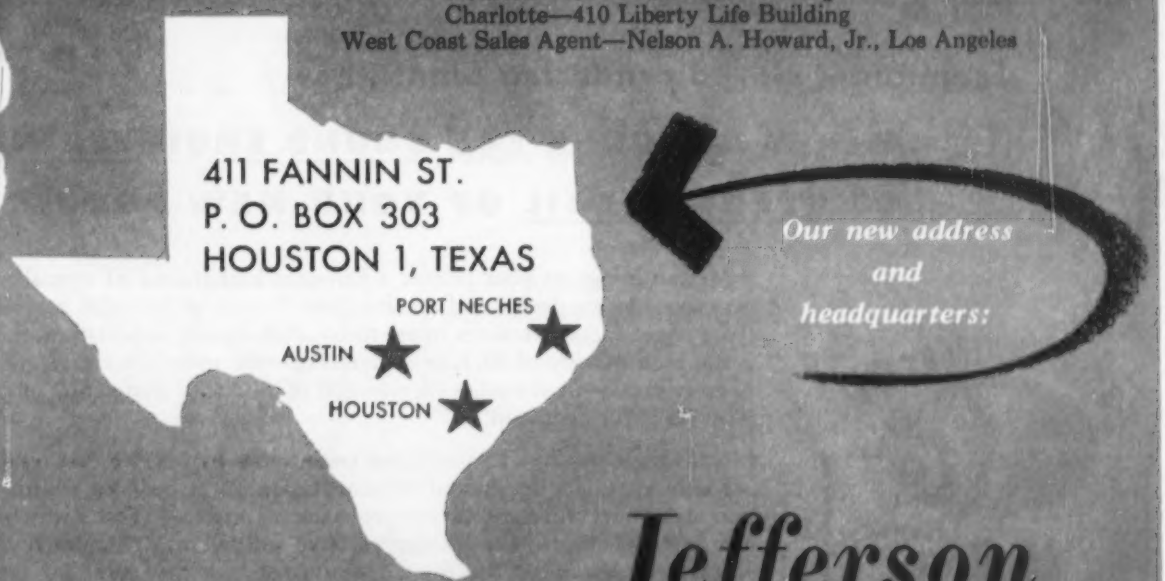
JEFFERSON CHEMICAL COMPANY, INC.

announces the transfer of its executive offices and marketing headquarters from New York to Houston, Texas

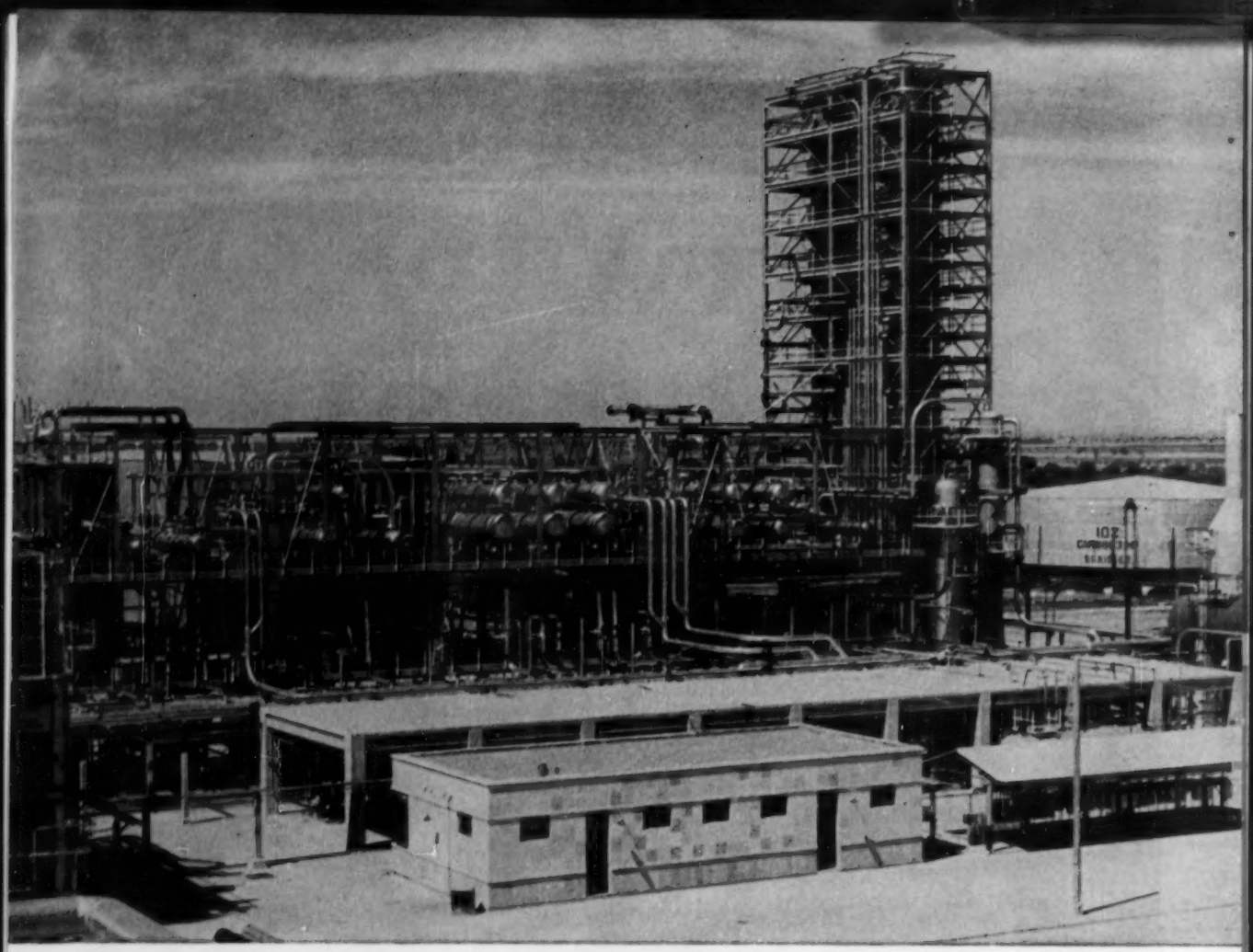
This move is being made to bring our administrative headquarters into closer integration with our plant at Port Neches and our laboratories at Austin. Through closer teamwork between operations and administration, we expect to bring you even better service on quality petrochemicals.

In addition to our branch office at 260 Madison Avenue, New York, district sales offices are:

Chicago—221 North LaSalle Street
Houston—1106 Prudential Building
Charlotte—410 Liberty Life Building
West Coast Sales Agent—Nelson A. Howard, Jr., Los Angeles



Jefferson
CHEMICAL COMPANY, INC.



From plant site to producing plant . . .

McKEE ASSURES YOU SOUND ENGINEERING OF EVERY DETAIL OF YOUR NEW PROJECT

● McKee brings to your project a fifty-year background of specialized experience in the design and construction of some of the most complex types of production facilities in use today. But, equally important to you, is the high *quality* of McKee engineering—the meticulous care given to every detail—from studies for selection of the site to completion of the plant ready for operation.

It's this high *quality* of painstaking engineering by McKee that results not only in correct design and efficient layout, but in reduced construction man-hours and most advantageous use of materials. That's why top men in the world-wide industries we serve will tell you "*McKee is the best name you can get*" on the engineering of your new plant.

50th ANNIVERSARY

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

The Mail Box . . .

How to Prevent Fatigue Failures

To The Editor:

Congratulations on the excellent article "You Can Prevent Fatigue Failures" appearing in the July issue of PETROLEUM REFINER. I would like further information or literature references on the inspection methods mentioned. My problem is this:

I have a number of vessels approximately two feet in diameter and from 5 to 7 feet long which are used in high-pressure (2500 psi) reactions. The openings into these vessels are only 2 inches in diameter making critical inspection of the inside extremely difficult. We have used radiographic inspection with Cobalt 60 on the welded joints with some success, but the magnetic powder inspection method and the supersonic method may well be applicable.

Dow Corning Corporation
By D. E. Hook
Midland, Mich.

Author's Reply

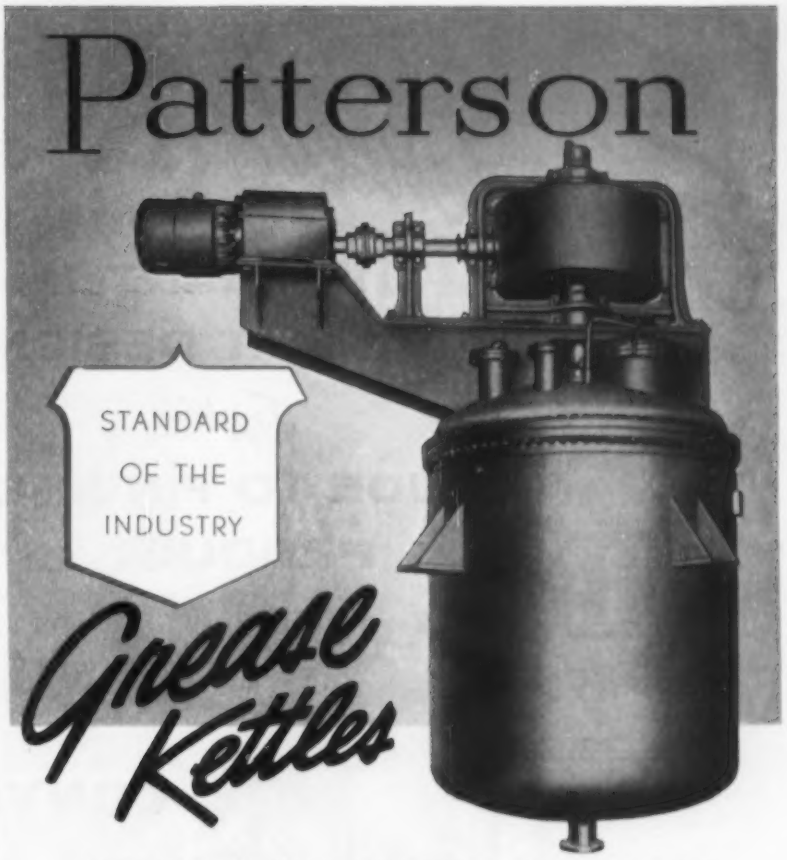
You have a good problem. With the dimensions and pressure mentioned, the wall thickness is in the order of 2¼ inches to 2½ inches. The magnetic powder method will only show defects at or near the surface; thus it would not be applied to the o.d. and give any information about the i.d. A possible method of using the magnetic method occurs to me however.

In one variation of this method, the indicating magnetic powder is coated with a dye which fluoresces under ultra-violet light. It is suspended in a liquid applied by spraying. The i.d. could be sprayed, and the inspection made by inserting a mirror and ultra-violet lamp through the openings. We believe that the patents on this method are still in force. Moreover the ampere-turns required for this wall thickness exceed what can be drawn from a shorted welding machine.

Some literature references on the magnetic method are: (1) "Improved Tools Expedite Magnetic Particle and Penetrant Inspection," A. H. Allen, Metal Progress, Jan. 1954, p. 161; (2) "Non-Destructive Testing of Structures," L. J. Oye, Welding Journal Vol. 33, 223-233, March, 1954; and (3) Metallurgia No. 1, Vol. 50, p. 78-80, August, 1954. Abstracts of papers on non-destructive testing at the 1954 Meeting of the Inst. of Physics., Great Britain.

With regard to the ultrasonic method, there are heads which transmit at an angle of 45 degrees. The signal, of course, penetrates the entire wall, so the inspection could be made from the outside. The equipment can be leased or agents of the manufacturers can be retained to make the inspection.

Some references are: (1) "Portable Ultrasonic Instruments," Peter K. Block, Metal Prog. 65, p. 161, March 1954. (2) "Some Basics of Ultrasonic Inspection," E. F. Weller, Jr., Materials and Methods 40, p. 154, Aug., 1954. (3) "Ultrasonic Inspection for Internal Pipeline Corrosion," S. K. Gally, O & G J, August 3, 1953, p. 61. (4) "Ultrasonic Testing of Pressure Vessels," Chem. & Ind., p. 865, Aug. 15, 1953. (5) "Testing of Pressure Vessels," Sperry Products, Inc., Bulletin 50-765. (6)

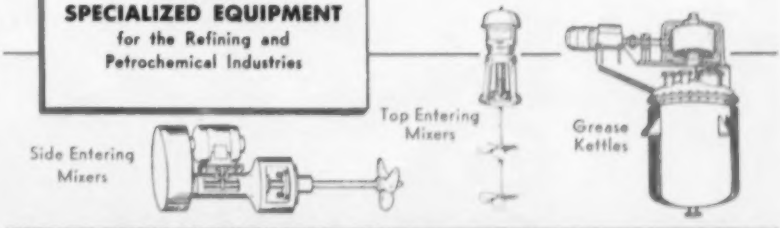


FOR PROFITABLE PRODUCT PROCESSING

The Patterson Grease Kettle is built in sizes to meet standard requirements for most economical batch processing of grease products. This equipment is used throughout the industry: let us give you the detailed reasons why!

Richard L. Cameron
President

PATTERSON SPECIALIZED EQUIPMENT
for the Refining and Petrochemical Industries



The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE

The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

For more data on advertised products, use Readers' Service Cards, last page.

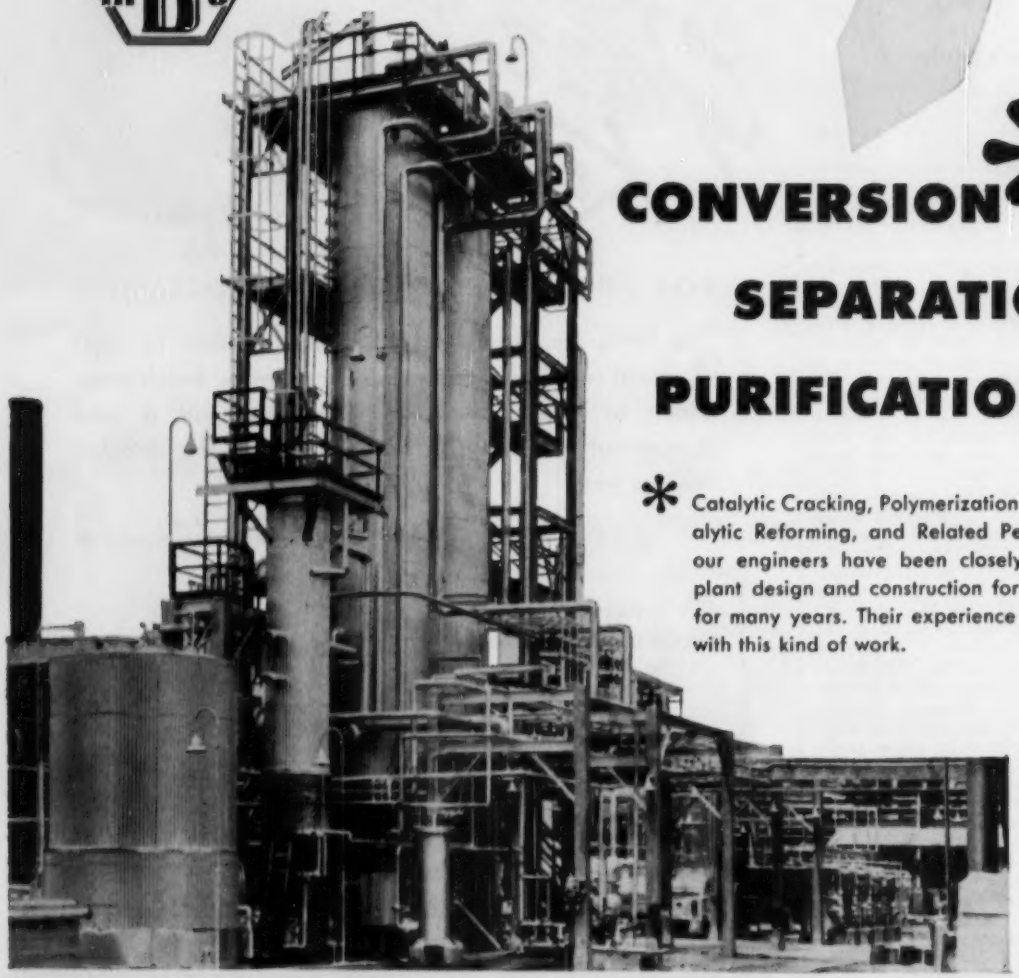
Experienced

IN PLANT AND UNIT DESIGN

From

CRUDE TO FINISHED PRODUCT

mBc



CONVERSION*

SEPARATION

PURIFICATION

* Catalytic Cracking, Polymerization, Alkylation, Catalytic Reforming, and Related Petrochemicals . . . our engineers have been closely identified with plant design and construction for such processing for many years. Their experience is tied in closely with this kind of work.

BADGER MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. • 60 EAST 42nd STREET, NEW YORK 17, N.Y.

The Mail Box . . .

"Ultrasonic Equipment Testing in the Petroleum Industry," Dwight J. Evans, O & G J, Feb. 4, 1952. (7) "Ultrasonic Flaw Detection in Pipes by Means of Shear Waves," C. D. Moriarty, Trans. ASME, April, 1951. (8) "Field Inspection of Boiler Tubes with Ultrasonic Reflectoscope," Trans. ASME, Feb., 1952.

W. G. Dudley and J. J. McKetta

Favors Convention Topics

To the Editor:

You asked in a letter that I react to certain questions. For whatever it may be worth to you I am making a number of observations with the viewpoint of being constructively critical as a reader. I trust you will receive these comments in this spirit and, of course, if you do not like them, consign the letter to the wastebasket.

(1) I heard or have had independent reports on the papers at NGAA and API and I regard your selections for publication as good. Sometimes we are not represented at some industry meetings and do not secure preprints. In such case we rely on journals such as yours for such articles. If you select all as well as in the cases of NGAA and API in the May issue, one could have no complaint. The article, "What We'll Be Making in 10 Years," suggests you should set up a tickler for 10 years hence and then compare these predictions with actualities.

(2) I was well impressed with the quality and variety of advertisements in the issue. The press work was excellent. I like the type used and composition of your articles.

(3) In reading with a critical eye through the section, "As Management Sees It," it seems to me, although you have given consideration to this title heretofore, that it is not clearly descriptive of the contents. I get the idea from the context that you are no so much reporting the management view as you are presenting ideas which you deem should be of interest to and should attract Management. I conclude, therefore, that some such title as one of the following: "For Management Eyes," "Ideas for Management," "For Better Management," "The Management Slant," or "Ideas for the Boss," would more nearly fit.

Geo. P. Bunn

Bartlesville, Okla.

"Second To None"

To The Editor:

For sometime I have been taking my PETROLEUM REFINER to the office and notice very much interest among the several engineers. In fact, several of them are now receiving their regular copy. I have become a confirmed salesman for it, and I would like to thank you and your staff for all the valuable knowledge I have acquired through reading your nice magazine.

PETROLEUM REFINER, in my opinion, is second to non. Thanks and with best regards.

M. Boone,

Catalytic Construction Company,

Kingston, Tenn.

HOW YOU BENEFIT WITH GIRDLER CATALYSTS

Cuts consumption of nickel 50% with

GIRDLER G-12 CATALYST

at Celanese Plant, Bishop, Texas

APPLICATION: Hydrogenation, employing a nickel type catalyst.

TECHNICAL SERVICE: Girdler engineers suggested installation of a supplementary G-12 catalyst case for further purification of the hydrogen.

RESULTS: Has cut consumption of expensive hydrogenation catalyst in half.

Technical personnel of the Girdler Catalyst Department will gladly assist you in your catalyst problems. Write for a copy of Bulletin G 260.,

the GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION: New York, San Francisco

VOTATOR DIVISION: New York • Atlanta • Chicago • San Francisco

In Canada: Girdler Corporation of Canada Limited, Toronto

For more data on advertised products, use Readers' Service Cards, last page.

What it takes to make a 3000 Degree Refractory Concrete

Because of the widespread interest in the use of refractory castables, many furnace operators have asked us for the story behind the performance of B&W's unique refractory concrete, Kaocast.

Here are the answers to some of the most frequently asked questions:

Q. *When you refer to Kaocast as a 3000 degree refractory castable, do you mean that its melting point is 3000° F?*

A. No, this means that its service use limit is 3000° F; its melting point is 200 degrees higher.

Q. *Just what does it take to make a 3000 degree refractory castable like B&W Kaocast?*

A. Let's first define a few terms. Refractory castables are made with granular materials which are volume stable at high temperatures and which can undergo repeated heating and cooling cycles without disintegration. These materials, known as refractory calcines or grogs, are blended with suitable hydraulic binders. The initial strength of a refractory castable is thus developed in the same manner as that of ordinary concrete—that is, through the chemical action between water and the binder. A strong *ceramic bond* is formed when the refractory castable is subjected to temperatures above the vitrification point.

Q. *Then you have a grog, a binder and a method of putting them together. Which is most important?*

A. You can't say that any *one* is most important. It's a combination of all three. Let's take them one at a time. Our grog consists primarily of the proper blend of kaolin and other alumina-silica materials. This ratio enables us to achieve a grog with minimum expansion and shrinkage, a high fusion point, and greater stability under load, at varying temperatures.

Q. *And now, what about the binder?*

A. There are a number of factors responsible for the success of the Kaocast binder. One is the compound Tricalcium Penta-aluminate (3 lime to 5 alumina). This formula produces the most refractory compound (highest melting point) that can be made from lime and alumina. Another is that by using the purest commercially available lime and alumina, the Kaocast binder is substantially free of iron and silica. Such traces of these that are present combine during the pre-firing of the binder to produce stable compounds.

Q. *Just how important is the manufacturing or "blending" of the grog and the binder?*

A. If one factor could be singled out as "most important" it would be quality control.

Direct control over the fineness of materials, prefiring temperatures, and other phases of manufacture is possible at B&W because both the grog and the binder are made and blended at B&W's Augusta Works—under B&W's direct control and supervision.

Q. *These factors you've discussed must add up to some specific advantages of Kaocast. What are they?*

A. B&W Kaocast has all the advantages of easy installation which are responsible for the widespread interest in refractory concretes, plus these exclusive features: It is the only 3000 degree refractory concrete with high resistance to spalling and low volume change throughout its operating range.

THE BABCOCK & WILCOX CO.
Refractories Division
General Offices:
161 East 42nd St., New York 17, N. Y.
Works: Augusta, Ga.

(Advertisement)

A Quick Look at the Industry THIS MONTH

Petroleum REFINER
October, 1955

Business continues boom. That's the biggest trend to watch today. The $385 billion gross product rate for second quarter of 1955 represented an advance of about 4 percent over quarterly figure reached at earlier high point in spring of 1953.

-•-

Most rapid sales growth among major groups was recorded by chemical industry, up 16 percent from early 1953. Petroleum industry showed sizable gains too. Oil product demand was up 7% over 1954 during first half of 1955 and should easily average 6% gain for entire year.

Earnings reflected this upsurge, too. Oil companies showed 11% gain in first half. Second half earnings will be just as good; labor and material costs will rise but increased demand will cover them.

-•-

Outside U. S., net additions to petroleum investments (capital investments less earnings) were down in 1954 but count on some pickup when Iranian consortium reaches full speed. Drop in '54 was due mostly to higher earnings from countries where investments were previously heavy. Now reflects soundness of these investments.

Look for petroleum industry boom in Canada to continue though rate will not be quite as rapid. Reason: General economy is booming like U. S. Experts have coupled this with expanding export market for Canadian crude in the northwestern and middle U. S. to come up with a $2 billion capital investment in five years.

-•-

Only atomic power plants can provide power requirements of the future, some experts are convinced. It is predicted that in 25 years 65 percent of new power plants in the U. S. will be atomic.

Petroleum will still be the energy workhouse in 1975, oil company officials maintain. By then, with 80 million cars on the road (versus 50 million now), the industry will have all the market it can handle. And if people are working six fewer hours each week and paid 25 percent more, then the added leisure will mean added miles of travel.

-•-

Growth of plastics has been phenomenal but present developments will be dwarfed if plastics prove their worth as structural materials. One reliable estimate is that within 20 years plastics will account for half of all U. S. petrochemical output.

Just how big is polyethylene growing? By 1960 it will represent only a little over 11% of the 5.6 billion pounds of plastics consumed. Though this wonder plastic is expected to triple by then, others will also grow. Here's how: vinyls from 1954 sales of 950 million pounds to 2750 million in 1960; polystyrene from 609 to 1,407.9 million; urea and melamine from 225 to 325 million; and phenolics from 410 to 510 million.

-•-

High price of crude rubber to synthetic rubber (45 cents versus 23 cents per pound) is blamed mostly on speculators, since tab is much over actual cost of production. Bogie man is about here for crude plantations since B. F. Goodrich has been able to duplicate the crude rubber molecule (though not in production yet).

Even so, crude rubber will still be able to compete but price will have to be cut drastically.

Synthesized "natural rubber," if and when it comes, will not conflict much with GR-S. Both have their own superior applications.

Activity in synthetic rubber has picked up since sale of government-owned facilities. Goodyear Tire and Rubber Company is doubling capacity at Houston. First stage

A Quick Look at the Industry (continued)

is a $6 million expansion to 170,000 tons, up to 200,000 by 1957. Phillips Chemical Company plans 15% expansion at its Plains copolymer plant from 74 to 85.1 thousand tons per year. Firestone at Lake Charles is scheduled for 30% increase by end of year. Butadiene producers will of course follow in this production race to supply raw materials.

Butyl capacity also will be increased though it has been hit by tubeless tire trend. Future lies in development of markets for its special qualities. Already additional uses have developed that will use more butyl in each passenger car than was formerly used in five tubes.

—●—

Behind the purchase of Reilly Tar's cresylic plant at Newark is a complex story in raw materials. Reilly (well-known for coal tar chemicals) built the plant to process coal tars from Eastern coke plants used in gas-making. Pipelined natural gas to East curtailed this feed and a partial switch to petroleum waste streams was started. Reilly just sold out to Pittsburgh Consolidated Coal Company, who will expand plant in the direction of petroleum processing. But Pitt-Consol claims entry into chemical business is based on their coal carbonization know-how and will use fractions from carbonization as secondary feed. Name of new chemical subsidiary: Pitt-Consol Chemical Company.

—●—

Frequently overlooked in the gas turbine picture is what's going on in steamship and railroad industries—and what they mean to diesel fuel market. Union Pacific R. R. has been using gas-turbine locomotives for several years and U. S. Maritime Administration is about ready to test an experimental gas turbine ship. Also, the Navy has found that gas turbines are promising for auxiliary and booster power to main steam plants (when full power is wanted).

—●—

Two more small refineries will be shut down. Reason is still that it's more profitable to build a large, modern refinery than revamp a small, old one. Two latest: Continental will suspend refining operations at Glenrock and Ashland will shut down its Aetna refinery at Louisville. Louisville plant will be tied into Ashland's petrochemical operations. Conoco still undecided what to do with its Wyoming refinery.

—●—

Users of platinum (before refineries started using the precious metal) will likely wish that the oil industry had never entered the picture. Early September saw the price of platinum jump $11—to $91 an ounce—and this following a $1 hike in July. Demand has been so great that U. S. refiners have had to tap European sources.

—●—

Don't expect much bigger engineering classes during next few years. Though college enrollments are up, schools are still not able to handle all the students who wish to enroll. Reason: Not enough money avaiable for facilities. Carnegie Tech, for example, was in position to admit only one-quarter of prospective students (3500) this fall. Even state schools, which at one time turned students away, are now using screening tests to limit enrollment.

—●—

Wage boosts in coal industry put residual fuels in a little better light. Coal tabs were raised by 25 cents to 40 cents a ton but it's still not enough to make resid competitive everywhere. Resid prices on East Coast are still considered too high to take anything away from coal, may lose some accounts.

—●—

Fresh-water-from-sea-water received a shot in the arm when Congress raised to $10 million the appropriation for expanded research. Department of Interior will handle program.

ROCKWOOD ALL-PURPOSE FOAM can be used to blanket fires in alcohols, ethers, esters, ketones, as well as petroleum products.

Now... one FOAM extinguishes both petroleum and alcohol fires

New Rockwood All-Purpose FOAM does the work of two products. Simplifies training of fire fighting personnel and cuts down fire protection inventory. Rockwood All-Purpose FOAM quickly puts out fires in alcohols, ketones, ethers and similar water soluble materials as well as petroleum derivatives.

Rockwood All-Purpose FOAM reduces fire protection equipment for fire departments and plants which must deal with more than one type of fire hazard, and is ideally suited for Rockwood's SpotPROTECTION or fixed piping systems.

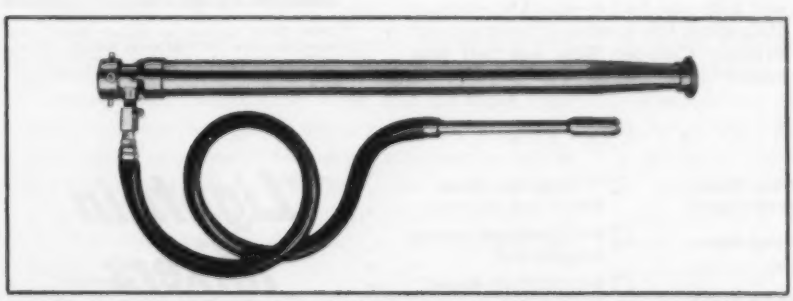
Rockwood All-Purpose FOAM is well suited for use by municipal fire departments, oil refineries, distilleries, chemical and other industrial plants.

Rockwood All-Purpose FOAM liquid with standard Rockwood FOAM nozzle provides the simplest, fastest means for extinguishing alcohol and solvent fires. The nozzle attaches to a hose connected to the discharge gate of a fire truck, hydrant or interior hose station.

Specify new Rockwood All-Purpose FOAM, put this versatile fire fighter to work for you.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses



1½" STANDARD FOAM NOZZLE AND PICK-UP TUBE discharges 60 g.p.m. at 100 p.s.i. Range: approximately 55 feet.

SEND FOR THIS INFORMATIVE BOOKLET

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
1085 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Rockwood fire fighting products.

Name.....

Title.....

Company.....

Street.....

City.....Zone..State.....

FOR TEL ADDITION, would you select this 25-HP LIGHTNIN with standard flange-mounted motor? Instead of a stuffing box, this mixer has a quickly-replaceable rotary seal cartridge that eliminates repacking entirely, and is lubricated by the liquid in the tank.

FOR BLENDING CRUDE would you choose a unit like this? It's a 25-HP LIGHTNIN, equipped with a standard foot-mounted motor and a packed stuffing box designed for pressures to 150 psig.

How to match any given set *of mixing or blending conditions*

Which mixer would *you* specify for a big blending job?

These pictures show just *two* ways you can buy LIGHTNIN Mixers to suit a specific mixing or blending operation.

There are many, many more ways to do this. For example:

MOTORS. You can order LIGHTNINs with the motor that gives you best service and minimizes your stock requirements: any make with NEMA frame; any current characteristics; any enclosure or insulation.

DRIVES. You can choose a highly efficient gear drive, or a lower-cost V-belt drive, for power input to the mixer. On gear drive LIGHTNINs, you can have a fluid coupling between motor and drive to handle excessively high starting torques.

SHAFT SEALING. You can specify the new rotary seal mentioned above (it's saving many oil companies several thousand dollars a year on maintenance). Or you can have your pick of *four* standard packed stuffing boxes, two of which permit repacking without draining the tank.

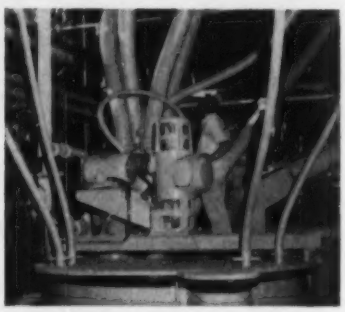
SIZES. You have a full range of sizes to choose from—18 basic models, 1 to 25 HP—so you get a mixer closely fitted to your needs.

MATERIALS. And you can write your own ticket on corrosion-resistant materials for shafts and propellers. You can get these wetted parts in *any* machinable metal or alloy—and with special covering if you want it.

You don't pay more for this freedom of choice. You *save*—because you cut your mixer operating, maintenance, and parts-stocking cost for *as long as the next 20 years.*

That's why it pays to look for the mixer that gives you *most choice* for the money.

Your LIGHTNIN Mixer representative will help you find it—quickly, without obligation. His name is in your copy of Refinery Catalog. Why not call him today?



GET THE ONE correct flow pattern that can give optimum fluid mixing results—with turbine-type LIGHTNINs for open or closed tanks. Hundreds of power-speed combinations are available, in sizes from 1 to 500 HP. Results guaranteed.

OPEN TANK becomes an efficient mixing vessel when you add a LIGHTNIN Mixer. Propeller unit, one of 30 models ranging from ¼ to 3 HP, tumbles and rotates the batch rapidly to achieve uniformity in least possible time.

Get these helpful facts on mixing: cost-cutting ideas on mixer selection; best type of vessel; installation and operating hints; full description of LIGHTNIN Mixers. Free—no obligation. Just check data you want, tear out and mail to us today with your name and company address.

- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller types)
- ☐ B-104 Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-110 Condensed Catalog (complete line)
- ☐ B-111 LIGHTNIN Rotary Mechanical Seals
- ☐ B-112 Laboratory Mixers

MIXING EQUIPMENT Co., Inc., 164-k Mt. Read Blvd., Rochester 11, N. Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists

Automation No Stranger Here

AUTOMATION. Here's a word that currently is rivaled only by "Davy Crockett" in its frequency of use and variety of application. From every direction we see and hear what it is going to do tomorrow. It looks to us like that tomorrow was many yesterdays ago in the petroleum industries—refining, petrochemicals, and natural gasoline.

It is hard to think of a single modern process unit that would operate at all, not to consider economics, without the familiar long used and well developed controls. Today's situation in instrumentation of plant, with the high percentage of total capital dollars spent, is a direct result of the ever-pressing demand for higher yields and better quality at lower cost. The thumb screws of competition always insure thorough economic justification of each capital dollar outlay. And the same evaluation must assure minimized operating and maintenance expense for the life of the unit.

Several recent speeches on automation by prominent authorities mention that plants in our industry have today what other industries hope to have in the near and perhaps not so near future. Also, numerous predictions are being made about the social impact of increased leisure and earnings resulting from industrial automation. These predictions seem well founded when today's situation of process plant employe is compared with almost any other industry group.

Much time and money is going into further application of available equipment such as data reduction and logging devices, computers, analyzers, and programmers. Continuous stream analysis to reset control of process variables is another integral factor. This trend goes hand in glove with the close coupled process units operating from a single control house.

Recently two major oil companies have announced that they are in fact using computers to determine end product quality balances from material in process data. The important feature seems to be that the rapid solutions available through the use of computer equipment will permit adjustment of process activities to obtain the optimum yields and qualities based on feeds and processing conditions at the time rather than having the inherent time lag of manual evaluation that has heretofore been the rule.

It is interesting to note in recent manufacturers announcements that several firms are concentrating on the design and manufacture of a relatively standard small-scale computer installation which is intended to fit the plant and pocketbook of the normal industrial establishment. The thinking has gone rather far into details of the application and one concern holds forth its simplification of physical design to minimize maintenance problems and thus side-step the heretofore complex technician requirement for computer application.

Several new plants recently placed on stream boast full-scale electronic instrumentation with built-in data logging equipment. This seems to give much validity to the feeling that the first long steps are being taken throughout the industry and each organization is undoubtedly well on its way to the gradual adaptation of full-fledged data processing and evaluation.

Coupled with this trend is the recent offering of several types of continuous stream analysis equipment as standard catalog items manufactured in volume. This equipment availability plugs one of the last gaps in the fully automatic control chain. Economics alone seems today to be the only limitation to what is possible now.

By-products of the atomic age have also entered the field of instrumentation in the form of radio isotope measuring devices. Presently available devices employing radio isotopes provide a convenient tool for measuring tank levels or stream densities without penetrating the vessel or piping. This is particularly important in services involving the difficult-to-handle class of products.

As is always the case in acceptance of increasingly complex devices there also comes the responsibility to man the plan with competent service and maintenance personnel. Thus the fullest use and benefits are derived from the more complex and effective equipment. This particular thing is viewed by many as being the more difficult portion of the evolution of automation.

The question of where and how to obtain the number of people with the very comprehensive know-how is getting a tremendous amount of top level attention. By the same token this demand for large numbers of highly skilled technical service and maintenance employes is the force that tends to up-grade the over-all social and economic position of the employe groups. Without question, the process industry will continue at a rapid pace, and to lead the field in industrial automation.

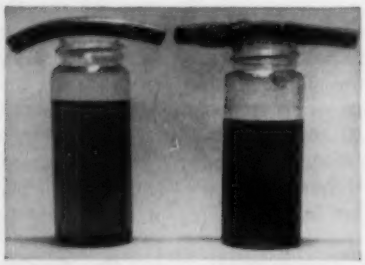
Avoid **gel-clogged** *fuel line complaints with Du Pont Metal Deactivator*

A rash of complaints due to clogged fuel lines causes headaches among fuel oil refiners and marketers during any heating season. And, as you might expect, the fuel oil is often blamed for causing the trouble.

A careful study of the problem reveals that clogging generally occurs in the line leading from the fuel oil storage tank to the burner, or at the screen in front of the fuel pump. And this clogging is generally due to the formation of a *gelatinous* material.

Copper causes the trouble

Since the feed-in line and the screen are often made of copper, they are a potential source of copper mercaptides which, if formed in sufficient quantities, become gelatinous in nature. You can assure better customer relations by protecting your oil against this gel formation with Du Pont Metal Deactivator in addition to Fuel Oil Additive No. 2, which guards against sludge.



Left, fuel and copper tubing stored for two weeks with 0.05 wt. % mixed mercaptans and 0.1 theory of Metal Deactivator. Right, fuel and copper tubing stored for two weeks with 0.05 wt. % mixed mercaptans without Metal Deactivator.

Low-cost insurance

In most fuel oil stocks, Du Pont Metal Deactivator is highly effective in low concentrations (about 2 pounds per 1000 barrels). This means that you can adequately insure yourself against the harmful effects of copper and promote better customer relations at a cost of less than ½ cent per barrel.

Du Pont Metal Deactivator was originally developed to prevent copper from accelerating harmful gum formation in gasolines. It also has valuable application in kerosines, diesel fuels, turbine oils and jet fuels.

A booklet describing the properties, uses, and methods of addition of Du Pont Metal Deactivator is available. If you do not already have a copy, ask any of our representatives or regional offices listed below to send you one.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

Regional Offices:
NEW YORK, N.Y.—1270 Ave. of the Americas . . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—P.O. Box 730 . . . . . Phone LUther 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . Phone CApitol 5-1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond St. W., Toronto 1, Ont.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building, 6539—Wilmington 98, Delaware

This Morning's Research

RADIO, TELEVISION, nylon, sulfa drugs, penicillin and the release of atomic energy all coming into the world's social and economic picture within one day!

Our tremendous acceleration in making new discoveries, products and devices may be visualized by compressing the supposed 500,000 years of man's development into 50 years, or a period comparable with our own lifetime. Forty-nine of those years was required for man to cease being a nomad; and only within the last three or four days we really found out how to use electricity. On such a condensed time scale, jet planes, dozens of new antibiotics and the release of atomic energy all came into the picture this morning.

This interesting projection, made by Dr. Robert E. Wilson, Standard Oil Company (Indiana) prompted his conclusion that the main factor in this relatively recent progress has been applied research, carried out on an expanding scale, mainly by industry.

Industry sees research as an offspring of one of man's greatest discoveries—how to discover. By being more thorough in our thought processes, we are aware of common phenomena which previously had eluded our attention. We now create situations which allow us to observe many heretofore uncommon phenomena.

Recently we have seen the application of the scientific method to fields such as maintenance, management, and many others. These applications have introduced into our vocabulary such terms as "engineering maintenance" and "operations research." Truly we are on our way to even greater strides in technology and understanding.

Distillate Oils at Peak

HIGH REFINING rates are continuing, and product stocks are threatening to become excessive. Particularly, the heating oils promise to enter the winter draw-down season in greater volume than is necessary or desired.

Distillate fuel oil inventories gained almost 11½ million barrels during the four weeks ending September 16, boosting those stocks to a new all-time peak. Distillate totaled 141¼ million barrels on September 16, which was 17¼ million barrels more than was in tanks a year ago. Since they will continue to build until, at least, the first of November, the industry seems certain to meet the heating season with a peak level of supplies, which could prove burdensome.

Since the end of March, a total of 79 million barrels has been added to heating oils stocks, while in the same period of 1954 only 63 million barrels were tanked.

Refinery runs averaged better than 7½ million barrels per day since the first of June this year, about 600,000 barrels a day more than operations in the same period of 1954. If activity is held to that rate, stocks of distillate, and possibly gasoline, will grow too great, and have a strong tendency to upset the favorable economic position that has existed so far this year.

Gibbs Named Refiner Editor

GEORGE B. GIBBS, who has served on the Editorial staff as Process and Construction Editor for some four years, effective September 1 became Editor of PETROLEUM REFINER. Announcement of this promotion was made early last month by Publisher Ray L. Dudley.

George B. Gibbs

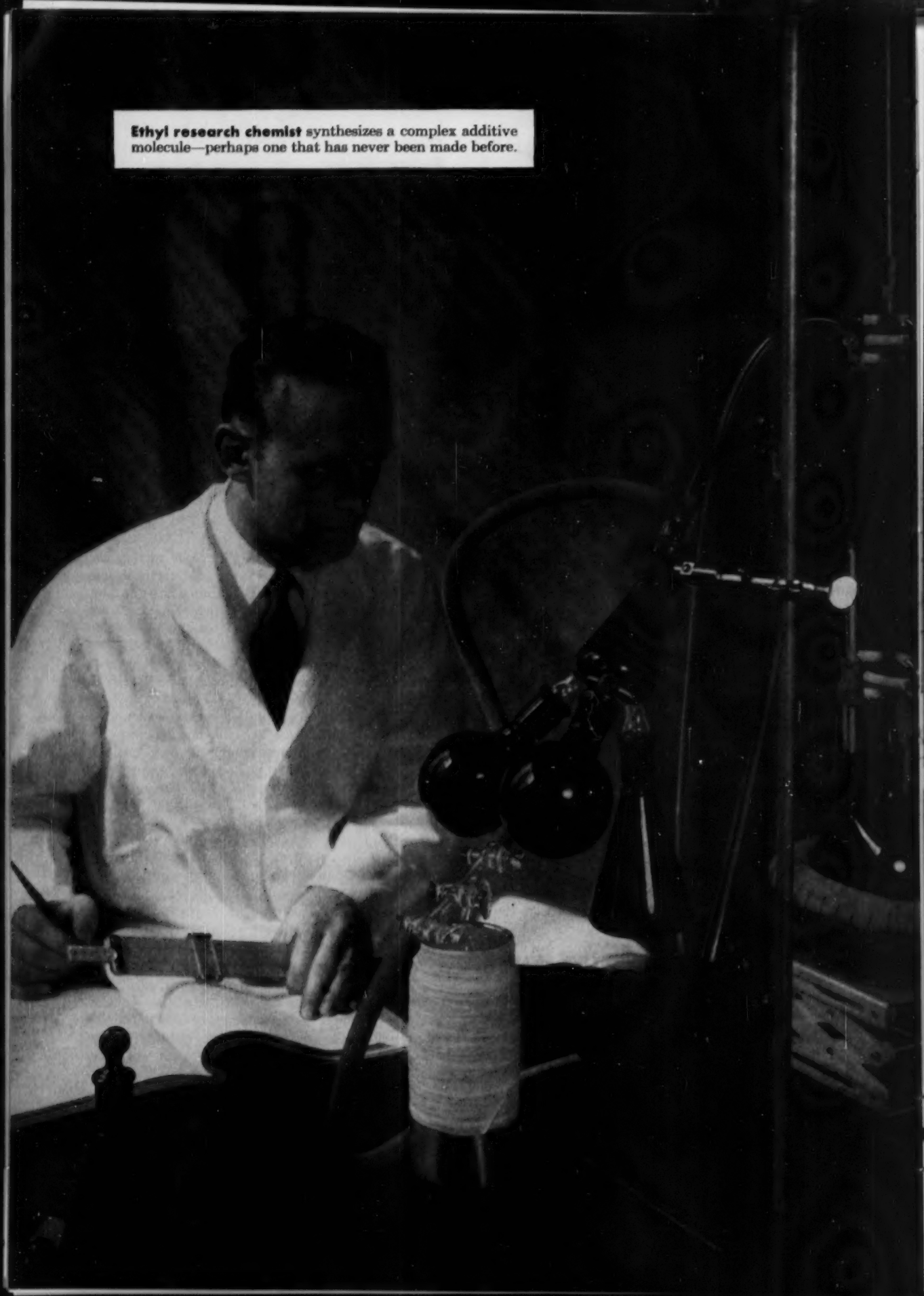
"George Gibbs has really earned this advancement," Dudley said. "He has done in a splendid manner every assignment given him. He is peculiarly fitted by education and experience to hold the job. He has shown the ability to keep his feet on the ground. He has a thorough working knowledge of processing, is widely acquainted with industry men and we feel sure his selection as Editor is a wise one"

Gibbs received a degree of Bachelor of Science in Chemical Engineering at the University of Texas—finishing well toward the top of his class—and an ensign's commission in the U. S. Navy at the same time. After discharge, he was selected for The Dow Chemical Company Student Training Program and upon completion at Midland, Michigan, was transferred to Freeport, Texas, as a research and development engineer. In 1948, he signed up for two years with Arabian American Oil Company as chemical engineer, this after spending six months with The Texas Company at Lawrenceville, Ill., in a refinery training program. With Aramco he was a chemical engineer in the Research and Development department at the Ras Tanura refinery and at Dhahran.

He returned to the University of Texas in 1950 where he obtained his Master's degree in chemical engineering, doing his thesis work on water-hydrocarbon solubility under Dr. John McKetta, now chairman of PETROLEUM REFINER's Editorial Committee.

He came to the REFINER in September, 1951. The Process Issues of 1952, '53, '54 and '55, including two handbooks, were largely his handiwork. In recent months he has given considerable of his time to assisting Editorial Director, Silas B. Ragsdale in the over-all editorial responsibilities. Gibbs is a member of American Chemical Society and American Institute of Chemical Engineers and presently is program chairman of the South Texas Section of AIChE.

"We are pleased to have a man of Gibbs' training and experience at the helm of our technical staff," Publisher Dudley said. "He is a thorough workman, has a fine grasp of industry needs and editorial problems and, we are certain will make his mark in maintaining the REFINER's editorial excellence and adding to its usefulness from the reader's viewpoint. He has that rare combination which makes for a successful technical publication editor—excellent technical training plus the urge and ability to put his thoughts on paper."



Ethyl research chemist synthesizes a complex additive molecule—perhaps one that has never been made before.

No. 399 puts Ethyl Research nearer the answer

At last count our chemists had just developed compound No. 399 in the search for a gasoline additive to combat a specific engine-fuel problem—so today we're just that much closer to a solution of the problem.

It's no secret that "finding" a new additive takes time and imagination. For example, before we developed "Ethyl" Antiknock Compound, several thousand different elements and compounds were tested. And more than 300 compounds were tested before the new "Ethyl" Diesel Improver was perfected.

Usually a petroleum additive depends for its action on a single chemical element or grouping of elements. To find it may take months or even years of research.

The next step—and often the most difficult—is to discover the best chemical structure to contain the element. How can its atoms be arranged so that it will act at just the right time and place? Many new compounds (some of which have never been made in any laboratory) may have to be synthesized before the right one is found. This calls for the highest type of creative ability.

It is in additive development that the vast knowledge and experience of Ethyl Research is so important. Our contacts with both the petroleum and automotive industries give us a unique insight into fuel needs. That's why you can continue to look to Ethyl Research for advancement in petroleum additives.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

Evaluation of every additive calls for the combined talents of experienced research chemists and engineers.

Additives synthesized at Ethyl Laboratories represent thousands of hours of laboratory work.

BEC D'AMBES—Fifty miles from the sea, the Bec D'Ambes refinery is on deep water 15 miles north of Bordeaux, France, at the confluence of the Garonne and Dordogne rivers where they join to form the Gironde. The plant has been completely rebuilt since it was destroyed by repeated bombing attacks in World War II. This is only one of several war-damaged refineries rehabilitated by Caltex.

Meeting the Postwar Products Demand

Caltex one of the companies with worldwide operations which has been particularly busy in the last decade repairing wartorn plants, expanding old facilities and building new units.

Howard B. Nichols, Vice President, California Texas Oil Company, Ltd., New York

AT THE END of World War II the Caltex group of companies ran a single 60,000-barrel-per-calendar-day refinery at Bahrain, in the Persian Gulf. Today, Caltex operates or has interests in ten additional refineries operating in eight other countries of the Eastern Hemisphere. With their combined capacity of 400,000 barrels a day these installations have made the Caltex group one of the world's largest processors of crude oil.

In addition, Caltex has two new refineries under construction. One, at Kurnell, near Sydney, Australia, with a design capacity of 22,000 bpcd, is scheduled for 1956 completion. The second is at Visakhapatnam, half way up the east coast of India on the Bay of Bengal. Its design capacity is 13,500 bpcd and it is expected to go on stream in 1957.

Throughout this growth and the sweep of postwar events that brought a vast increase in world demand for petroleum products along with great changes in refining techniques, The Bahrain Petroleum Company's plant remains the keystone of the group as well as one of the largest refineries of the world. While its nominal capacity is 186,500 barrels a day, crude running averaged 190,000 bpcd in 1952, 200,000 in 1953, and 214,000 in 1954.

POSTWAR demand for petroleum products fooled many an oil company economist. But when consumption kept going up throughout the world, oil companies met the situation, as they usually do, and started a tremendous building program. PETROLEUM REFINER in a series proposes to show what some of the leading companies did in their postwar program. Caltex appears first. Next month, The Texas Company.

Meanwhile, the refinery's employe strength has grown from 5700 in 1945 to more than 8500 in 1954 with more than a 60 percent increase in the number of Bahraini employes. This is in keeping with the Caltex policy of training and employing nationals in all 67 countries of the Eastern Hemisphere where the group operates.

The growth of Bahrain typifies the growth of the entire Caltex group. During the war the refinery underwent an expansion program that made it a major source of strength to the Allied armed forces in the air,

afloat, and ashore. It helped support campaigns in the Middle and Far East from North Africa to Burma as tankers crowded day and night at its busy wharves.

The war made heavy demands on Bahrain's equipment and its people, as it did on others. Because of this a continuous expansion program was carried out all through the hostilities to double its prewar capacity of 30,000 bpcd. One of the wartime facilities that had been constructed was the first fluid catalytic cracking unit to be built and go into operation outside continental U.S.

After V-J Day, this unit was shut down because of the sharp, sudden fall-off in demand for aviation gasoline. But by converting a section of the idle unit to crude running service, and by removing bottlenecks in other key parts of the refinery, crude running capacity was increased to 135,000 bpcd in 1947 and to 150,000 in 1948. This high throughput, made necessary by the postwar market, strained Bahrain's facilities, making it necessary to ease the situation by undertaking what we called the "1947-49 Construction Program." This was intended to:

a) reduce overloading of the equipment and generally balance out the capacity of the refinery, and
b) diversify production, and in certain instances, to enable manufacture of higher-grade products.

General view of the Caltex refinery at Batangas, in the Philippines, south of Manila. Units shown are, left to right, the refinery water cooling tower, propane decarbonization plant with vent stack, yard office, gas recovery plant, catalytic cracking unit, and catalytic polymerization unit. Crude distillation facilities are not shown.

The new program provided additional thermal reforming and vacuum distillation capacity. And the catalytic cracking unit was converted for single-stage operation. In addition, an asphalt plant (present capacity 100,000 tons a year) was completed in 1947.

After completion of the 1947-49 program, 1950 saw the building of yet another crude still with a capacity of some 75,000 bpcd, replacing and increasing the crude previously run through the idle cat cracking equipment. This in turn permitted extensive modernization of the catalytic cracker for production of high octane motor gasoline blend stock.

Near the end of 1951, as the modernization of the cat cracker was being completed, the Abadan situation came to a head, and Bahrain, along with other refineries, was called upon to process more crude. As a result, certain of the catalytic cracking equipment, idled by the modernization, was again converted into a fifth crude unit of 33,000-bpcd capacity.

The present program at Bahrain is essentially one of quality improvement. It calls for completion of a 26,000-bpcd vacuum unit this year, and by 1957, catalytic-reforming facilities.

Today, the refinery ships products to Western Europe, the Far East and the Middle East, Australia and Africa.

War Damaged Plants—A special category of the Caltex postwar expansion program included rehabilitation of war-damaged plants in France and Japan.

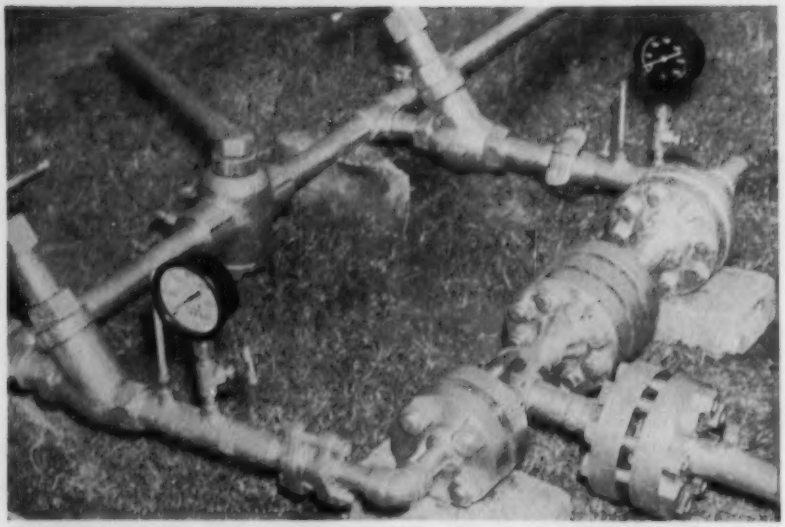
Fifty miles from the sea in Bec d'Ambes stood the ruins of a 6500-bpcd refinery built in 1932. This plant was first bombed in 1940 and Allied strategic aerial warfare nearly obliterated it over the course of four more years. The attacks were so heavy the Germans made no attempt to restore it and used the site as a storage place for military tanks.

After the war, with demands for petroleum products soaring and most of Europe's refineries in ruins, the French government established a policy of rebuilding plants by awarding war-damage claims. Caltex offered to combine this with a $10-million investment and the loan of refinery engineering technicians. The plant was rebuilt and enlarged. Crude running,

(See CALTEX, page 226)

Meet the Author

HOWARD B. NICHOLS, a director, vice president and member of the Executive Committee for California Texas Oil Company, Ltd., has been engaged in the petroleum refining industry since 1923, when he was graduated from Stanford University and immediately joined Standard Oil Company of California. He spent 14 years with SOCAL, most of which was devoted to research and process development work at the company's Richmond, Calif., refinery. He was particularly active in the advancement of cracking techniques. In 1938 he became manager of research and development for The Bahrain Petroleum Company, Ltd., rising to assistant vice president in 1944 and becoming vice president in charge of refining in 1947. He was elected a director and vice president in charge of refining for the Caltex group in 1949.



Typical field installation of a gas jet compressor at lower right. High-pressure gas enters at lower left and compresses low-pressure gas entering from right. Discharge at upper right is into intermediate pressure system.

How to Design and Operate Gas Jet Compressors

Here is a low-cost method of putting low-pressure gas into high-pressure gas lines.

Frank H. Dotterweich and C. V. Mooney,
Texas College of Arts and Sciences, Kingsville, Texas

THE GAS JET compressor is a simple device with no moving parts which enables low-pressure gas to be entrained into a stream of high-pressure gas. It is a new application in the natural gas industry, yet it employs basic principles of gas entrainment practiced since the discovery of the Bunsen burner. In these jet entrainment operations, a gas under pressure is allowed to expand with a resulting increase in velocity and, as it passes through a restriction gas or fluid at a low pressure, is entrained. The velocity of the resulting mixture is reduced and the pressure increased to that above the gas entrained.

Development and use of this equipment has been increasing rapidly. This trend will continue because of many installations where high-pressure natural gas is available which must be reduced in pressure principally along delivery points in natural gas transmission line operations.

The uses to which the gas jet compressor is being put, to a great extent are where pressure of the motive and suction gas do not vary. Under these conditions, the gas jet may be designed, built and placed in satisfactory operation. There is a great opportunity for the application of gas jet compressors in natural gas practices, especially on dually-completed gas wells where both high-pressure and low-pressure gas are available, and where there is an intermediate pipe line pressure. Although the gas jet compressor is relatively inexpensive, a large part of its costs is for engineering design work. Likewise, the gas jet compressors presently available must operate very close to design conditions since any change in operating pres-

Mooney Dotterweich

Meet the Authors

FRANK H. DOTTERWEICH, director of the Engineering division at Texas A&I College, has written some 50 articles on gas technology. A graduate of John Hopkins University, where he also received his Ph.D., Dr. Dotterweich has been a member of the engineering faculty at the South Texas college since 1937, except for four years spent as a consultant to the Petroleum Administration for War. In addition to heading the college's Engineering division, he is in charge of its Short Course in Gas Technology and serves as director of the Southern Gas Association Management Development Program.

C. V. MOONEY, also author of several technical articles for the natural gas industry, is professor of engineering at Texas A&I. He joined the faculty at his Alma Mater in 1947, after completing a master of engineering degree at the University of Oklahoma in 1948. Before taking up teaching, Mooney served as a gas technologist with the Bureau of Mines at Bartlesville, Okla. He and Dr. Dotterweich are registered engineers in Texas.

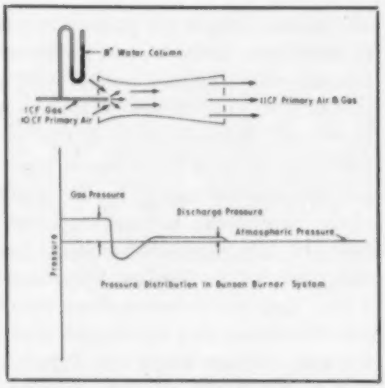


FIGURE 1—Conditions of flow in a Bunsen burner demonstrate quite well the theory of a gas jet compressor.

sure seriously impairs its performance. Therefore, it appears that a gas jet compressor so designed to give flexible operating characteristics by adjustment in the field would do much to encourage the use of such equipment. The development of such a gas jet compressor to operate satisfactorily in the field would make additional quantities of low-pressure gas available with a large saving in the capital expenditure.

Applications. The gas jet compressor may be used in any number of applications where two gas streams (one at high-pressure, the other at low-pressure) are to be combined to form a gas mixture at some intermediate pressure. Warner[4] has discussed the design, performance and application of the gas jet in gas mixing. Fletcher[2, 3] notes various gas jet applications including one in which high-pressure natural gas from a transmission line was used to boost manufactured gas to distribution line pressures. In this operation, a large utility company effected a great saving in capital expenditure by replacing obsolete motor-driven centrifugal compressors with gas jet compressors.

Theory. The theory of the gas jet compressor may be better explained by observing the conditions of flow existing in a low-pressure Bunsen-type burner system. Such a system is shown in Figure 1. One cubic foot of natural gas could entrain 10 cubic feet of air required for its complete combustion, provided the pressure at the orifice was about 8 inches of water pressure and orifice size and burner

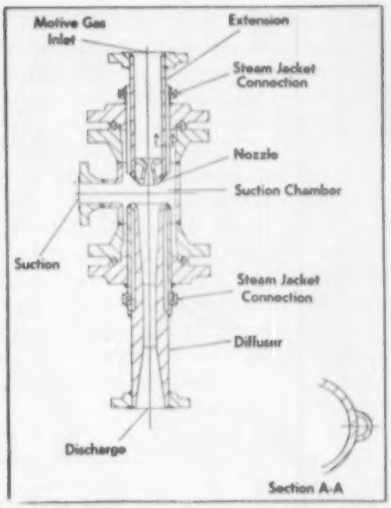


FIGURE 2—Gas jet compressors shown in cross-section is relatively simple. It consists of four main parts: a suction chamber, a nozzle extention, a nozzle and a diffuser.

proportions were designed correctly.

In this case, the design was based on the assumption that for a given burner, the momentum (product of mass and velocity) of the gas as it leaves the orifice, bears a sufficiently constant ratio to the momentum of

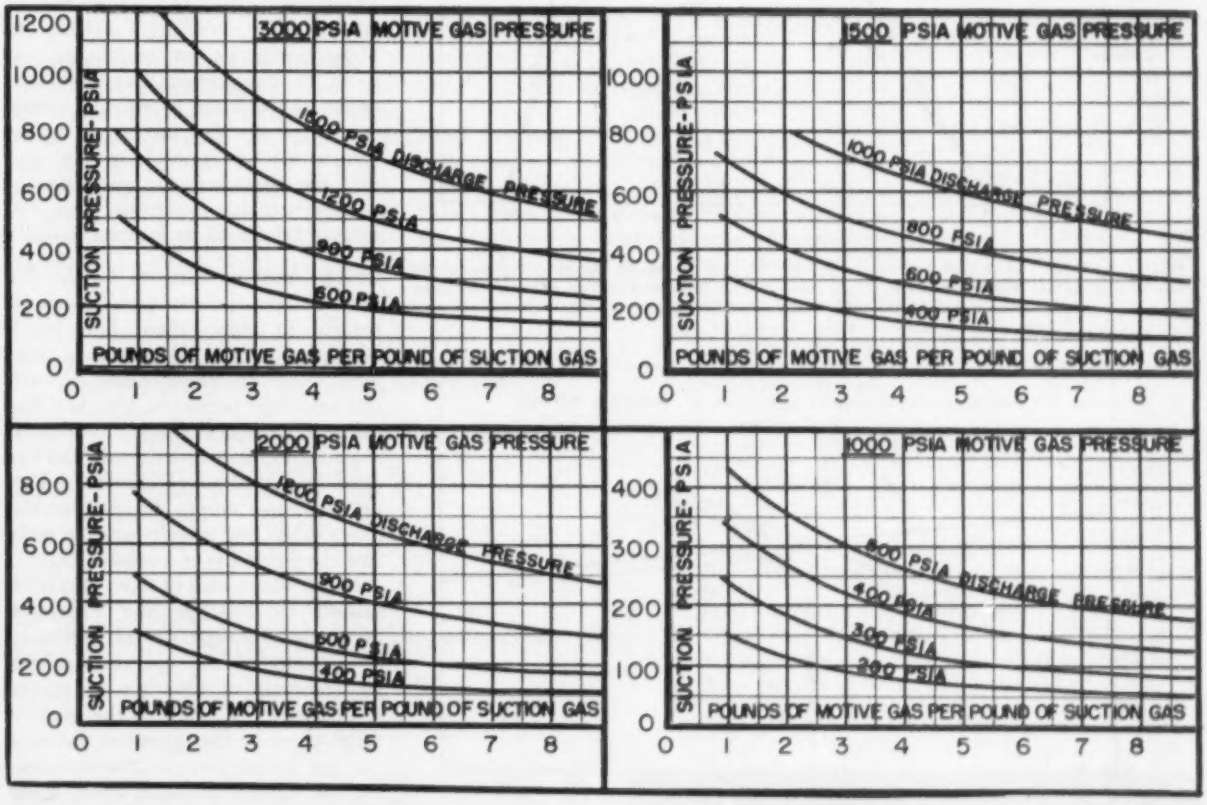


FIGURE 3—Requirements of high-pressure motive gas to compress a gas of the same density to several discharge pressures shown above are qualitative and merely serve to indicate the possibility of a certain project. Data developed by Fletcher.[1]

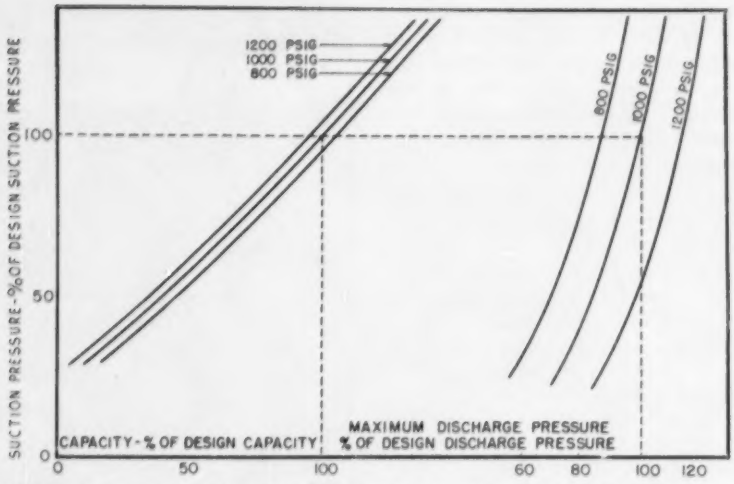


FIGURE 4—Performance curves developed by Fletcher[1] show characteristics that may be expected in the operation of gas jet compressors.

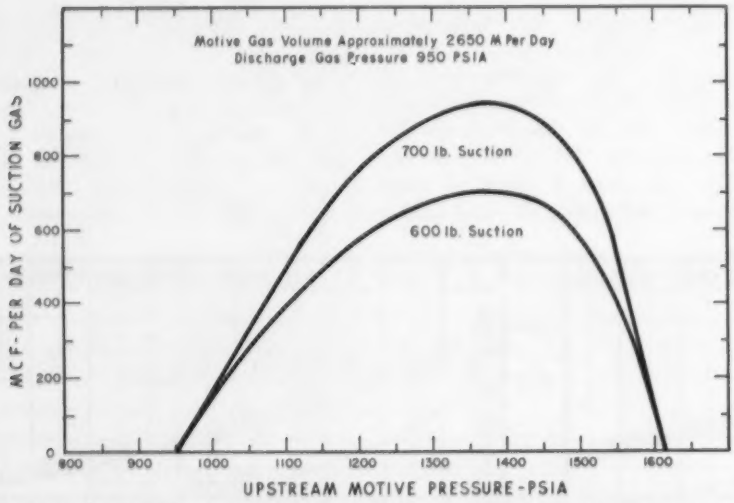


FIGURE 5—Volume of suction gas compressed to 950 psia by varying motive gas pressure and maintaining suction pressure constant. Upper curve is for a 700-pound suction pressure; the lower curve for 600-pound suction pressure.

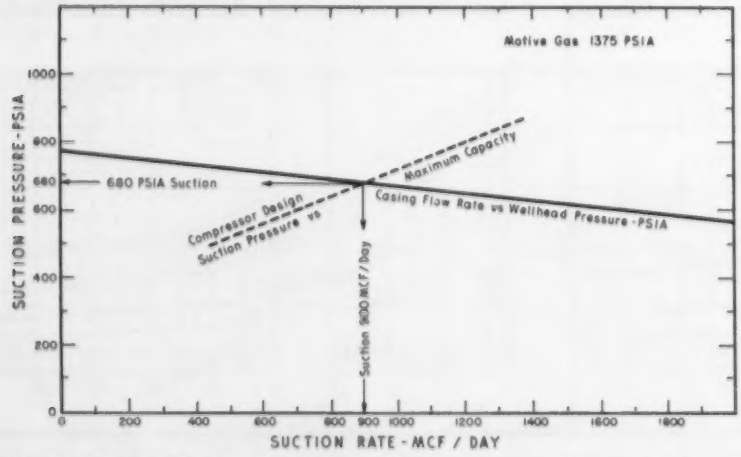


FIGURE 6—Quantity of suction gas that can be compressed to 950 psia by varying the suction pressure and maintaining motive gas pressure constant at 1375 psia.

the mixture of gas and primary air as it passes any definite cross section of the burner, to permit use of such a constant in most design problems. A theoretical demonstration of this relationship involves assumptions which are not justified except by the result of the experiments themselves. Therefore, the rule is entirely empirical but very helpful in design operations. These theoretical assumptions, to a certain extent, are confirmed when the unit is placed under test. Figure 1 also indicates the pressure distribution throughout the system from the motive pressurized natural gas, the suction air and the discharge mixture above the normal atmospheric pressure.

In the so-called gas jet compressor shown in Figure 2, higher pressures and velocities are used. The high-pressure gas expands through a converging-diverging nozzle with an accompanying decrease in pressure and temperature and with little increase in entropy of the gas. As a result, velocities of 2000 to 3500 feet per second may be obtained. The entrainment properties of this high velocity jet pull low-pressure gas into the jet stream. The resulting mixture of high-velocity jet gas and large volumes of low-pressure entrained gas enters the diffuser where the kinetic energy of the gas mixture is transformed into pressure. It can be seen that the operation of a gas jet compressor is highly dependent upon design and finish of its internal parts.

Design and operation. In the design of gas jet compressors, it is helpful to know about how much high-pressure gas is required to compress gas of the same density to various discharge pressures. Fletcher[1] has given this subject of gas jet compressor design concentrated study and has developed the curves shown in Figure 3. These curves do not give the exact value, but merely serve to indicate the possibility of a certain project.

Performance curves have also been studied by Fletcher and Figure 4 notes characteristic curves that may be expected in the operation of gas jet compressors. One set of curves is obtained by holding the motive (high-pressure gas) pressure constant varying the suction gas flow and noting the suction pressure. From these data, the percent of design capacity versus the percent of design suction

pressure may be plotted. Should the motive and suction pressures be maintained constant, and the discharge line gradually closed with the discharge pressure building up, the jet will maintain constant suction pressure until a critical discharge pressure is reached. At this point, the suction pressure will increase. The discharge pressure at which this occurs has been defined[1] as the "maximum back pressure."

By determining this maximum back pressure at several suction pressures, a curve may be developed to show the relationship of maximum discharge pressure, and as percent of design suction pressure. These curves indicate that for a gas jet to perform as desired, the motive pressure must not fall below design pressure unless the discharge pressure is also lowered. Also, the discharge pressure should not be increased above the design pressure unless the motive pressure is increased.

Formulae that are helpful in the design of gas jet compressors have been developed and are noted in Appendix I, Section 1. Calculations for the design of a gas jet compressor to fit a certain field requirement is given in Appendix I, Section 2.

Efficiency low. These calculations indicate that the gas jet compressor has an over-all efficiency of about 20 percent. This low efficiency limits the number of conditions in which it can be used. An ideal situation for its use is where high-pressure gas is available that must be reduced in pressure before it can be transported or processed. This high pressure energy, heretofore dissipated and wasted, is available through a gas jet compressor to boost low-pressure gas to pipe line pressure. It is this application that has been studied in the laboratory and by field installation.

No servicing required. In the operation of a gas jet compressor, little or no servicing or maintenance is required for the inexpensive unit. However, it must be accessible for inspection.

Hydrate problem. As the high-pressure gas expands in the nozzle (Figure 2) with ensuing high velocity, low temperatures are encountered. The temperature attained at the tip of the nozzle may be so low that hydrate formation will result, and the build-up of solid particles may interfere with operation. This hydrate formation may be eliminated by heating the motive gas, which is an expensive and rather difficult procedure. Hydrate formation at the nozzle will interfere with jet operation only when it adheres to the nozzle. Therefore, should the nozzle be heated sufficiently to prevent the solids from adhering and building up, satisfactory operation can be assured. The nozzle and diffuser can be heated electrically or with small quantities of steam applied to jackets as noted in Figure 2.

Field studies. Studies on gas jet compressors were limited to theoretical calculations and a study of laboratory units until a gas jet compressor was made available for field study by the courtesy of James E. Pew of Sun Oil Company. This compressor has been used in a cooperative research program with engineers of The Chicago Corporation on dually-completed gas wells in the Stratton Field of Texas.

The jet compressor as received from the Sun Oil Company had been designed for operating conditions other than those encountered on the dually-completed gas well available for test in the Chicago Corporation production field. It was redesigned as noted in the appendix to conform to these new conditions.

The results of one series of tests are shown in Figures 5 and 6. It will be noted in Figure 8 that about 910,000 cubic feet of 700 pounds per square inch absolute gas was compressed to 950 psia gas by 2650 Mcf of 1375 psia motive gas. When the suction pressure on the well dropped to 600 psia, the same compressor with no alterations in nozzle or diffuser, compressed 700 Mcf of 600 psia gas with 2650 Mcf of 1350 psia motive gas. Figure 6 has been developed to show the quantity of suction gas that could be compressed to line pressure 950 psia as the suction gas pressure varied. The jet compressor in this field installation performed a duty which would call for conventional compression equipment requiring many times the amount of capital investment and operating expense.

LITERATURE CITED

[1] Fletcher, George R., "Gas Jet Compressors," *Power and Fluids*, Fall 1954, page 12.
[2] Fletcher, George R., "Gas Jet Compressors," *Power and Fluids*, Fall 1953, page 10.
[3] Fletcher, George R., "Gas Jet Compressors," PETROLEUM REFINER, Feb., 1954, page 107.
[4] Warner, C. W., "Gas Mixing with Jet Compressors," *Gas*, September, 1954, page 90.

APPENDIX 1—SECTION 1. DEVELOPMENT OF FORMULA FOR THERMAL COMPRESSOR PERFORMANCE CALCULATIONS

I. Symbols:

p — pressure, pounds per square inch absolute.
T — absolute temperature, degrees Rankin.
s — entropy, British thermal units per pound—degrees Rankin.

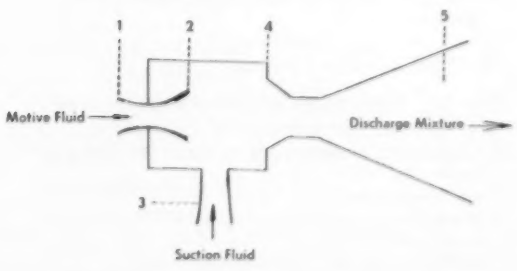


FIGURE 7—Schematic drawing of gas jet compressor to identify determination points used in calculations.

C_p — specific heat at constant pressure, Btu/lb.—°R.
k — ratio of specific heats, C_p/C_v.
h — enthalpy, Btu/lb.
v — velocity, feet per second.
w — pounds suction fluid compressed per pound motive fluid.
g — gravity, feet per second^2.
J — mechanical equivalent of heat, 778 foot-pounds/Btu.

II. Assumptions:

A. Flow is frictionless (viscosity of fluid is zero).
B. Expansion in nozzle and compression in diffuser are isentropic.
C. Motive fluid is the same as the suction fluid.
D. Calculations are based on 1 lb. of motive fluid.
E. Mixing occurs at constant pressure and is adiabatic.
F. Total enthalpy of the mixture is the average of the total enthalpies of the components.
G. Velocities at points 1, 3, and 5 (Fig. 7) are negligible

Compressor Aids

compared to those at 2 and 4.

H. Pressure at 2, 3, and 4 are equal.

III. Methods of calculation:

A. Derivation of General Relations

1. According to assumption F,

$(1 + w)\, h_3 = h_1 + w h_2 = h_1 - h_2 + h_2 (1 + w)$

$$h_3 = h_2 + \frac{h_1 - h_2}{1 + w} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

2. Applying assumptions A, B and G ($v_3 = 0$) to the equation expressing the conservation of energy for the diffuser yields,

$$h_4 = h_3 - \frac{v_4^2}{2gJ} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

3. Applying assumption E to the equation for the conservation of momentum during the mixing process,

$v_2 = (1 + w)\, v_4$ ..... (3)

Squaring both sides and dividing by 2gJ yields,

$$\frac{v_4^2}{2gJ} = \left(\frac{1}{(1 + w)}\right)^2 \frac{v_2^2}{2gJ} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

4. Applying assumptions A, B, and G ($v_1 = 0$) to the equation expressing the conservation of energy for the nozzle yields,

$$\frac{v_2^2}{2gJ} = h_1 - h_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

5. Substituting equation (5) into (4) and the result into (2) gives

$$h_4 = h_3 - \frac{h_1 - h_2}{(1 + w)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

B. Method of determining w as a function of p_3 if a Mollier, p-h, or other suitable state diagram is available for the gas or vapor.

1. Knowing h_1, h_2, and w, calculate h_3 from equation (1).
2. Calculate h_4 from equation (6).
3. From a Mollier chart, locate state at point 4 knowing h_4 and p_4.
4. Locate h_3 along isentropic from 4 (s = constant) yielding p_3.
5. Repeat steps 1-4 for different values of w.
6. From calculations of steps 1-5, plot curve of w vs. p_3 or w vs. p_3/p_4.

C. Determination of w as a function of p_3 based on perfect gas relations.

1. Derivation of Equation.

a. From equation (4),

$$(1 + w)^2 = \frac{\frac{v_2^2}{2gJ}}{\frac{v_4^2}{2gJ}}$$

b. Since for a perfect gas,

$\Delta h = cp \Delta T$ ..... (8)

and

$$\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}} = \frac{T_2}{T_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9a)$$

$$\left(\frac{p_4}{p_3}\right)^{\frac{k-1}{k}} = \frac{T_4}{T_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9b)$$

equations (2) and (5) become

$$\frac{v_2^2}{2gJ} = CpT_1\left(1 - \frac{T_2}{T_1}\right) = C_pT_1\left[1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right] \quad \ldots (10)$$

$$\frac{v_4^2}{2gJ} = CpT_3\left(1 - \frac{T_4}{T_3}\right) = C_pT_3\left[1 - \left(\frac{p_4}{p_3}\right)^{\frac{k-1}{k}}\right] \quad \ldots (11)$$

c. Substituting equations (10) and (11) into (7),

$$(1 + w)^2 = \frac{T_1}{T_3}\left[\frac{1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}}{1 - \left(\frac{p_4}{p_3}\right)^{\frac{k-1}{k}}}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

d. From equation (1)

$$\frac{T_3}{T_1} = \frac{T_2}{T_1} + \frac{1 - \frac{T_2}{T_1}}{1 + w} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

e. Substituting equation (13) into (12) and solving for w from the resulting quadratic equation,

$$w = \frac{1}{2T_2}\left\{\left[(T_1 - T_2)^2 + 4T_1T_2\,\frac{1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}}{1 - \left(\frac{p_4}{p_3}\right)^{\frac{k-1}{k}}}\right]^{\frac{1}{2}} - (T_1 + T_2)\right\}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

2. Procedure.

a. Substitute various values of p_3 into equation (14) and solve for w, keeping p_4, p_2, p_1, T_1 and T_2 constant.

b. Plot curve of w vs. p_3 or w vs. p_3/p_4.

APPENDIX I, SECTION 2
CALCULATIONS FOR THE DESIGN OF GAS-JET COMPRESSORS

Assumptions:

Line operating pressure = 700 psia = p_3
High-pressure (motive pressure) = 900 psia = p_1
High-pressure (motive gas) Temp. = 90° F.
High-pressure (motive gas) Sp. Gr. = 0.65
High-pressure (motive gas) $K = C_p/C_v = 1.28$ Btu/lb./°F.
Low-pressure (suction gas) = 500 psia = p_2
Low-pressure (suction gas) Temp. = 80° F.
Low-pressure (suction gas) Sp. Gr. = 0.65
Low-pressure (suction gas) $K = C_p/C_v = 1.28$ Btu/lb./°F.

Let $N = K\text{-}1/K = 1.28 - 1/1.28 = 0.219$

where

1. $K = 1.28$
2. $A = p_2/p_1 = 500/900 = 0.555$
3. $A^N = (0.555)^{.219} = 0.879$
4. $p_4/p_3 = 500/700 = 0.714 = C$
5. $C^N = (0.714)^{.219} = 0.929$

where (See Figure 10)

$p_2 = p_3 = p_4 = 500$ psia.
$p_1 = 900$ psia.
$p_3 = 700$ psia.

6. $t_1 = 90°$ F. $= 550°$ R. or $T_1 = 550°$ R.
7. $t_2 = 80°$ F. $= 540°$ R. or $T_2 = 540°$ R.
8. $A^N T_1 = 0.879 \times 550 = 483°$ R. or $T_2 = 483°$ R.
9. $T_1 - T_2 = 550 - 483 = 67°$ R.
10. $4T_1T_2 = 4 \times 483 \times 540 = 1.041 \times 10^6$
11. $(T_1 - T_2)^2 = 100$
12. $(1 - A^N) = 1 - 0.879 = 0.121$
13. $(1 - C^N) = 1 - 0.929 = 0.071$
14. W = lbs. of suction fluid compressed per lb. of motive fluid

$$W = \frac{1}{2T_2}\left\{\left[(T_1 - T_2)^2 + 4T_1T_2\left(\frac{1 - A^N}{1 - C^N}\right)\right]^{\frac{1}{2}} - (T_1 + T_2)\right\}$$

$$W = \frac{1}{1080}\left\{\left[100 + 1.041 \times 10^6\left(\frac{0.121}{0.071}\right)\right]^{\frac{1}{2}} - 1090\right\}$$

$W = 242/1080 = 0.224$ with 100 percent efficiency.

Assuming an efficiency of 65 percent through Venturi Section:

$$W = .224 \times 0.65 = 0.145\ \frac{\text{lbs. suction gas}}{\text{lbs. motive gas}}$$

$1/W = 1/.145 = 6.9$ lbs. of motive/lb. of suction gas

Vol/Vol = 6.9 Mcf motive gas/Mcf suction gas

2.5 Mmcf/day of motive will compress 362 Mcf/day of suction gas

Total flowing into line = 2.5 + 0.36 = 2.86 Mmcf/day

3 Mmcf/day of motive will compress 435 Mcf/day of suction gas

Total flowing into line = 3.435 Mmcf/day.

3.5 Mmcf/day of motive gas will compress 506 Mcf/day of suction gas

Total flowing into line = 4.06 Mmcf/day.

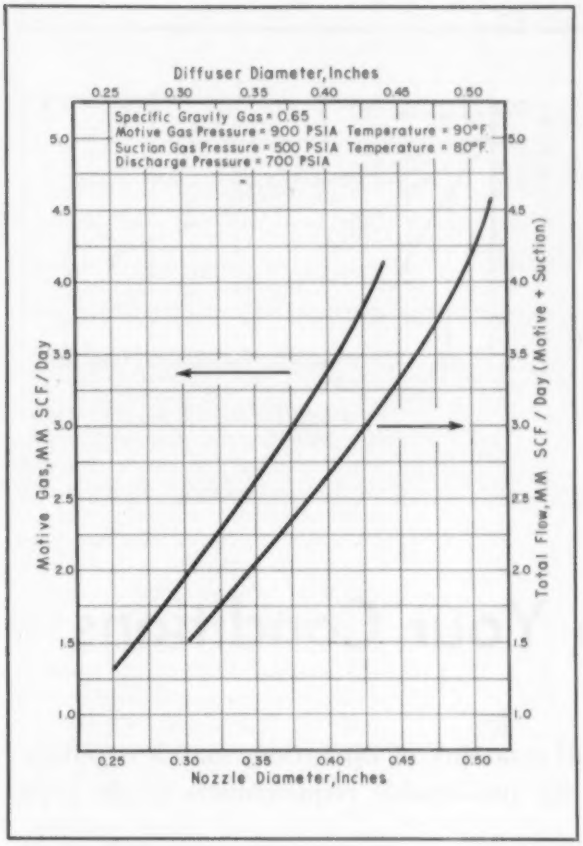

Diffuser Diameter, Inches
0.25 0.30 0.35 0.40 0.45 0.50
Specific Gravity Gas = 0.65
Motive Gas Pressure = 900 PSIA Temperature = 90°F.
Suction Gas Pressure = 500 PSIA Temperature = 80°F.
Discharge Pressure = 700 PSIA
Motive Gas, MM SCF / Day
Total Flow, MM SCF / Day (Motive + Suction)
5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
Nozzle Diameter, Inches
0.25 0.30 0.35 0.40 0.45 0.50

FIGURE 8—Relationships of nozzle diameter to total flow and diffuser diameter to rate of motive gas flow for one set of conditions noted on the curve.

Nozzle Design

1. Standard cu. ft./lb. motive gas $= \frac{379}{28.96 \times 0.65}$
   $= 20.15$ cu. ft./lb.

2. $\frac{2.5}{20.15}$ Mmcf/day motive gas $= 124{,}000$ lbs./day

   $\frac{124{,}000}{24 \times 60 \times 60} = 1.44$ lbs./sec. = weight

3. $v_1 = 20.15$ cu. ft./lb. $\times \frac{14.7}{900} \times \frac{550}{520} = 0.347$ cu. ft./lb.

4. $v_2 = v_1(p_1/p_2)^{1/k} = 0.347 \times \left(\frac{1}{.555}\right)^{\frac{1}{1.28}} = 0.55$ cu. ft/lb.

5. $V_2 = \sqrt{\frac{2gk}{k-1}(p_1v_1 - p_2v_2) + V_1^2}$

Assuming upstream velocity V_1 in flow line (neg.)

6. $V_2 = \sqrt{\left(\frac{2gk}{k-1}\right)(p_1v_1 - p_2v_2)} =$

$$\sqrt{\left(\frac{2 \times 32.17 \times 1.28}{1.28 - 1}\right)(900 \times 144 \times .347 - 500 \times 144 \times .55)}$$
$= 1250$ ft./sec.

7. $A_2 = \frac{Wtv_2}{V_2} = \frac{1.44 \times 0.55}{1250} \times 144 = 0.0912$ sq. in.

8. $A_2 = \frac{\pi d^2}{4}$ $\qquad d = \sqrt{A^2 \frac{4}{\pi}} = \sqrt{\frac{.0912 \times 4}{\pi}}$
   $= 0.341$ in.

Diffuser Design

1. scf/lb. $= 20.15$cf/lb.

2. $362{,}000/20.15 = \frac{18{,}000}{24}$ lb./day $= \frac{750}{60}$ lb./hr. =
   12.5 lb./min. $12.5/60 = 0.208$ lb./sec. suction gas

3. W = 0.145 lb. of suction gas per pound of motive gas

4. $T_2 = T_1\left[\frac{\frac{T_3}{T_1} + 1 - \frac{T_2}{T_1}}{1 + w}\right] = 550\left[\frac{\frac{540}{550} + 1 - \frac{540}{550}}{1 + .145}\right] = 548°$ R.

5. $v_2 = 20.15 \times \frac{14.70}{700} \times \frac{548}{520} = 0.446$ cu. ft./lb.

6. $v_4 = 0.446 \quad \left(\frac{700}{500}\right)^{\frac{1}{k}} = 0.446\ (1.4)^{.782} = 0.582$ cu. ft./lb.

7. $A_4 = \frac{(1.44 + 0.208)\ 0.582 \times 144}{1250 \times 0.85} = 0.130$ sq. in.

where 0.85 = coefficient of discharge

8. $d_4 = \sqrt{\frac{4 \times 0.130}{3.1416}} = 0.406$ in.

3 MM scf/day (motive) 0.435 MM scf/day (suction)

Weight of motive $= \frac{3\ MM}{20.15 \times 24 \times 60 \times 60} = 1.73$ lb./sec.

$A_{(nozzle)} = 0.11$ sq. in. $\qquad d = \sqrt{\frac{0.11 \times 4}{\pi}} = 0.374$ in.

3.5 MM scf/day (motive) 0.506 MM scf/day (suction)

Weight of motive $= \frac{3.5\ MM}{20.15 \times 24 \times 60 \times 60} = 2.02$ lb./sec.

$A_{(nozzle)} = 0.1285$ sq. in. $\qquad d = \sqrt{\frac{0.1285 \times 4}{\pi}} = 0.405$ in.

$(1.73 + 0.25) = 1.980$ total flow lb./sec.

Diffuser diameter $= 0.406\sqrt{\frac{1.98}{1.648}} = .445$

$(2.02 + 0.292) = 2.312$ total flow lb./sec.

Diffuser diameter $= 0.406\sqrt{\frac{2.312}{1.648}} = .48$

General Equation.

Nozzle diameter $= 0.341\sqrt{\frac{Q\ M\ scf/day}{2500}}$

Diffuser diameter $= 0.406\sqrt{\frac{(Q_{motive} + Q_{suction}) \times M\ scf/day}{(2500 + 362)}}$

900 psia motive pressure
500 psia suction pressure
700 psia discharge pressure

Motive Gas scf/day	Suction Gas scf/day	Nozzle Diameter inches	Diffuser Diameter inches
2500 Mcf/day	362 Mcf/day	0.341	0.406
3000 Mcf/day	435 Mcf/day	0.374	0.445
3500 Mcf/day	506 Mcf/day	0.405	0.480
2000 Mcf/day	290 Mcf/day	0.306	0.363
1500 Mcf/day	218 Mcf/day	0.264	0.315
4000 Mcf/day	580 Mcf/day	0.433	0.514

ACKNOWLEDGMENT

The authors wish to acknowledge the help and encouragement in this work by Walter B. Saner, James G. Badgett and Roy A. Schuster of The Chicago Corporation, and James E. Pew of Sun Oil Company.

Compressor Aids

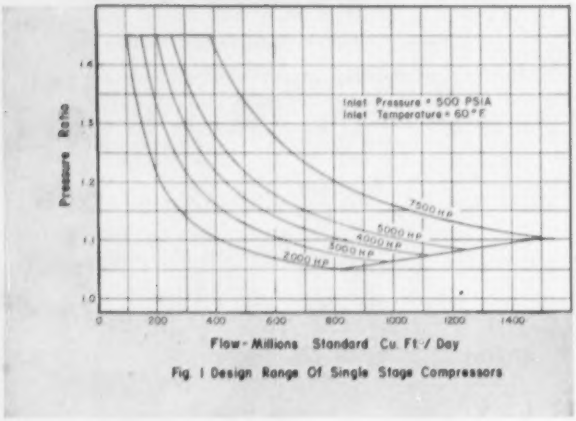


Fig. 1 Design Range Of Single Stage Compressors

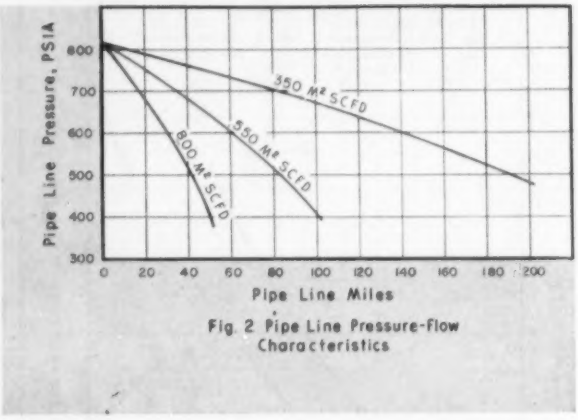


Fig. 2 Pipe Line Pressure-Flow Characteristics

Tailor Centrifugals to Your Conditions

To insure maximum flexibility and economy of operation, match carefully the known capabilities of the compressor and the predictable requiremnets of the pipe line.

C. F. Koenig and L. J. Holveck,
De Laval Steam Turbine Company, Trenton, N. J.

SINGLE-STAGE centrifugal compressors can be built for pressure ratios from 1.05 to 1.50, for flows from 100 to 1500 M³SCFD (million standard cubic feet per day) and for horsepower ratings from a few hundred to 15,000 or more. Higher pressure ratios may be readily obtained by multistaging; either by using more than one impeller in a single compressor or by connecting a number of single stage compressors in series.

Figure 1 shows the range of horsepowers, flows and pressure ratios within which modern centrifugal compressors may be designed to operate. Current operating pressures are from 500 to 1000 pounds per square inch, although higher pressures are being considered and can be handled with little difficulty. Shaft speeds may range from about 3000 to 10000 revolutions per minute, depending on the size of the compressor. Drivers may be electric motors, steam turbines, gas turbines or gas engines.

For most main line booster applications to date where centrifugal compressors have been used, the single stage machine has been selected. These compressors, each with driver, are installed in series in the station. Piping is arranged so that any combination of compressors may be put on the line as the load demands. Spare units may be provided, depending on the load factor of the pipe line.

Pressure-flow characteristics for a typical pipe line are shown in Figure 2. Such characteristics are determined by well known equations for pipe line flow or, more easily, by the slide rule designed by T. R. Rhea. The pressure ratio and horsepower required for centrifugal compressors to raise

Meet the Authors

C. F. KOENIG first joined De Laval Steam Turbine Company in 1940, following his graduation from Princeton University where he received a degree in electrical engineering. After three years in the company's Aircraft Turbosupercharger Design and Development program, he left De Laval to participate in aviation development projects with the Navy and with Westinghouse Electric Corporation, returning in 1947 to take a place in De Laval's Gas Turbine Design and Development projects. He was transferred to the company's Compressor department in 1951.

•

L. J. HOLVECK joined De Laval Steam Turbine Company in 1934, serving ten years in engineering liaison work with the Navy Department before receiving his present assignment as chief estimating engineer in the company's compressor operations. Holveck's background also includes a stint in pump designing with Aldrich Pump Company, which he joined shortly after graduation from Carnegie Institute of Technology in 1932.

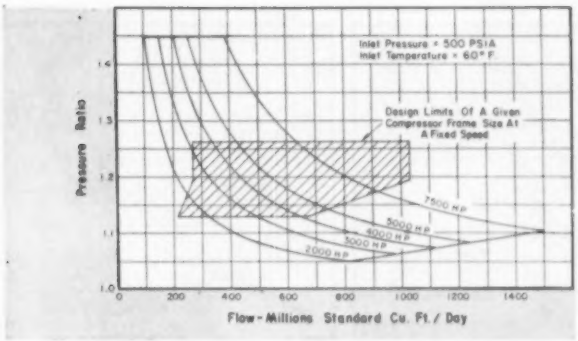

Inlet Pressure = 500 PSIA
Inlet Temperature = 60° F
Design Limits Of A Given Compressor Frame Size At A Fixed Speed
7500 HP
5000 HP
4000 HP
3000 HP
2000 HP
Pressure Ratio
Flow - Millions Standard Cu. Ft. / Day

FIGURE 3—Design range of single-stage compressors.

the pressure up to the starting pressure at any point along the line are shown in Figure 4. The actual volume of gas in cubic feet per minutes (CFM) is also shown to facilitate later discussion of the compressor characteristics. Finally, assuming a unit driver horsepower of 5000, single unit stations have been spotted at 130 mile spacing for the initial condition of 350 M²SCFD, two-unit stations at 65-mile spacing for the intermediate condition of 550 M²SCFD, and three-unit stations at 32.5 mile spacing for the ultimate condition of 800 M²SCFD.

Pressures, horsepowers and station spacings which will be involved for each growth step of the pipe line are shown in Figures 2 and 4. Attention must now be directed to selecting the compressors.

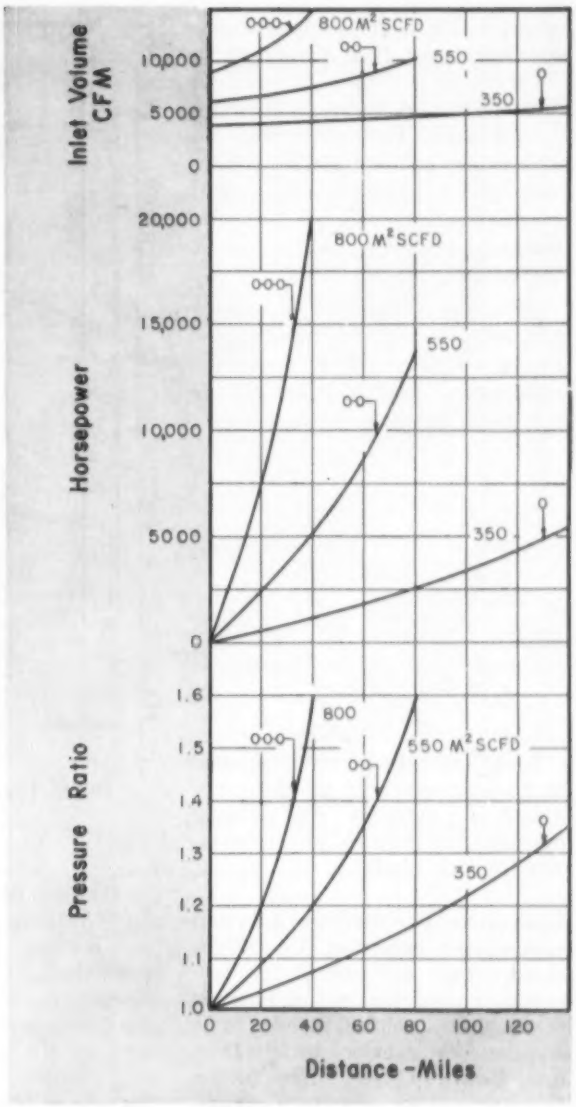


FIGURE 4—Compressor station location.

Design for ultimate load. Compressors should be designed for the ultimate requirements, but smaller capacity "innards," usually impellers, diffusers, and adjacent minor parts, may be necessary for early, low-capacity operation of the pipe line. When flow is increased to design value these small capacity impellers and diffusers may be replaced by those for the ultimate design. Most of the compressor —casing, shaft, bearings, seals, supporting structure, oil system, accessories, and controls—remains unchanged from the initial installation.

Through proper selection of the compressor size and speed it is usually possible to accommodate a growth in pipe line load of the order of two to one by changing impeller and diffuser. When flow is low, a small capacity, large diameter impeller which delivers a high pressure ratio is used. Greater flow requires substitution of a large capacity, smaller diameter impellers for lower pressure ratios. Additional compressors are then installed. The lower flow limit is determined by diameter limitations of the impeller, and also by performance which deteriorates at very low design flows. Typical design limits for a given compressor frame size under average pipe line conditions are shown in Figure 3.

Translate performance to pipe line language. A compressor designer usually prefers to describe performance in terms of actual inlet volume, head (work per pound of gas pumped) and efficiency. Pipe line calculations, however, are based on flow in standard cubic feet, pressure ratio, and horsepower. Some manipulation is necessary in order to obtain compressor characteristics which are readily usuable in application studies. Of many possible "systems" for relating compressor performance to pipe line performance, it is believed that the one illustrated here provides quickly the essential information needed for studying all possible conditions of operation of the pipe line and requires the least amount of incidental arithmetic.

Design points of the pipe line, the station spacing, and the installed horsepower have been established as

shown in Fig. 4. Pipe line flow characteristics have been prepared for 32.5, 65, 97.5, 130 and 260-mile station spacing, as shown in Figures 5, 6, 7, 8 and 9. These curves show station suction pressure, station pressure ratio, and actual inlet volume versus flow in standard cubic feet for several discharge pressures from the preceding station.

Referring to Figure 4 and also to the indicated pipe line design points in Figures 5, 6 and 8, the compressor requirements may be tabulated for the design points of the pipe line:

CONDITION	Initial	Intermediate	Ultimate
Flow, M²SCFD	350	550	800
Station Spacing, mile	130	65	32.5
No. Units per Station	1	2	3
Overall Station Pressure Ratio	1.315	1.390	1.395
Total Station Horsepower	4900	9650	14150
Station Inlet Volume, CFM	5300	8830	12900

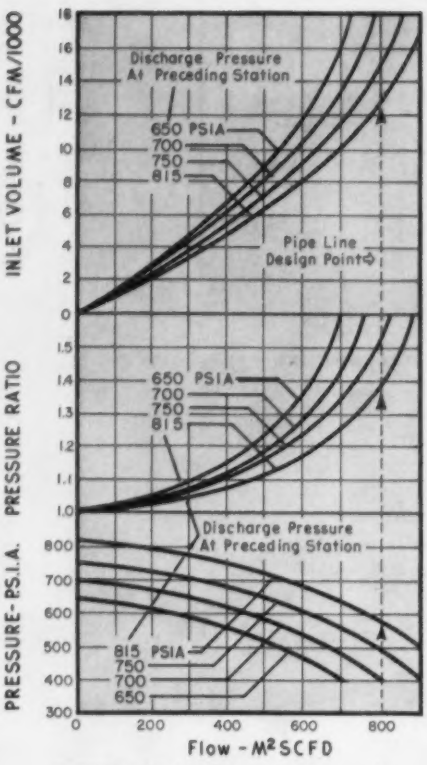


FIGURE 5 (left)—32.5-mile station spacing.

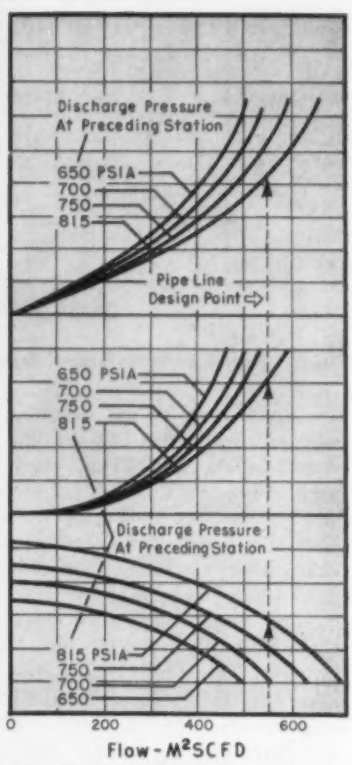


FIGURE 6 (right)—65-mile station spacing.

Flows and pressure ratios required of the compressors for the three conditions vary sufficiently that different impellers and diffusers will be necessary for each condition.

Operating conditions govern compressor selection. Compressor characteristics are selected for each operating condition, plotted in terms of actual inlet volume, pressure ratio, and horsepower divided by inlet pressure. Figure 10 shows the compressor characteristic for the initial condition, where one unit per station is used. Figure 11 shows the combined characteristic of two compressors in series required for the intermediate condition, and Figure 12 shows the performance of one of these compressors operating alone. For the ultimate condition, Figures 13, 14 and 15 show the characteristics of three compressors in series, two compressors in series, and a single compressor, respectively.

It is very important to consider all operating conditions which may occur before selecting the final compressor characteristic. Referring to Figure 10 for the initial design, the 130-mile line shows where operating points would fall for various flows with all stations running. The 260-mile line shows operating points with only alternate stations running. These operating lines are obtained directly from Figures 8 and 9. Maximum flow, with all stations running, is established by the power limit (115 percent or 5750 horsepower), and maximum flow with alternate stations running is established by the speed limit (110 percent).

Where multi-unit stations are used there are more possible combinations of operating compressors and the selection of a proper compressor characteristic becomes slightly more complicated. Figures 11 and 12 show the performance of compressors for the intermediate condition. They illustrate typical operating points to be checked so proper compressors are selected for this phase of pipe line growth. Pipe line characteristics for 65-mile and 130-mile spacing from Figures 6 and 8 are shown on both the single and two-unit curves

The performance of compressors selected for the ultimate operation of the pipe line are shown in Figures 13, 14, and 15. Pipe line charactertistics for different station spacings are again superimposed on the compressor characteristics to show quickly the operating points at various flows.

Performance characteristics for emergency operation. Emergency operations along a pipe line are periodically encountered. One or more units in a station—even a complete station—may unavoidably be "down." When this occurs the stations preceding the down station operate normally along the pipe line characteristic at reduced loads but at full discharge pressure. However, the station or stations following the down station will operate at points varying from the normal pipe line flow characteristic.

From these unusual operations, several examples of emergency conditions for each of the initial, intermediate and ultimate designs are cited.

Initial design 130-mile station spacing. For the initial design with 130-mile station spacing and one unit per station two phases of an emergency operation, with one station down, have been analyzed with the use of Figures 8, 9 and 10.

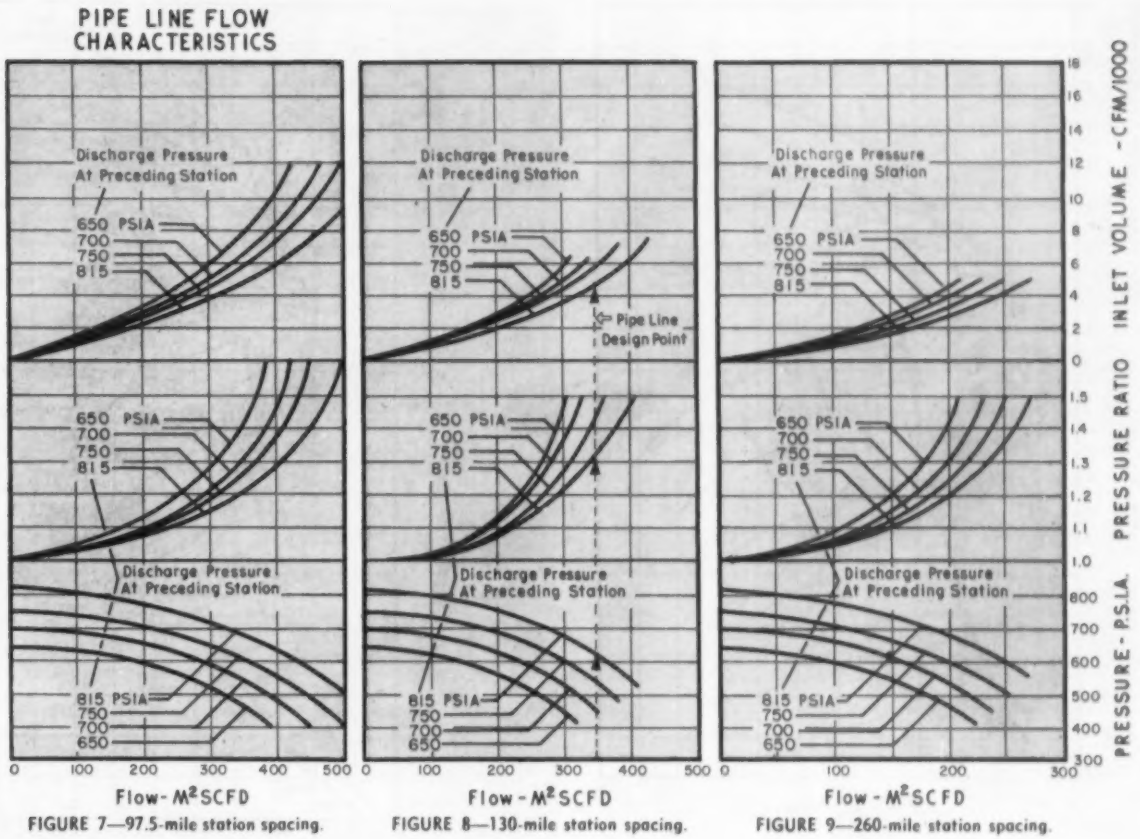


FIGURE 7—97.5-mile station spacing.

FIGURE 8—130-mile station spacing.

FIGURE 9—260-mile station spacing.

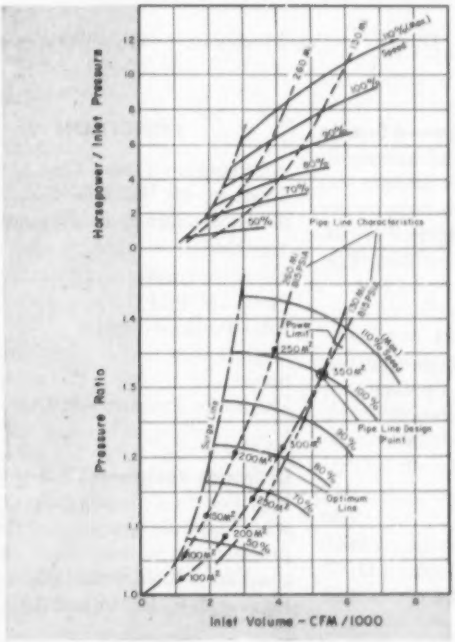


FIGURE 10—One-compressor initial design.

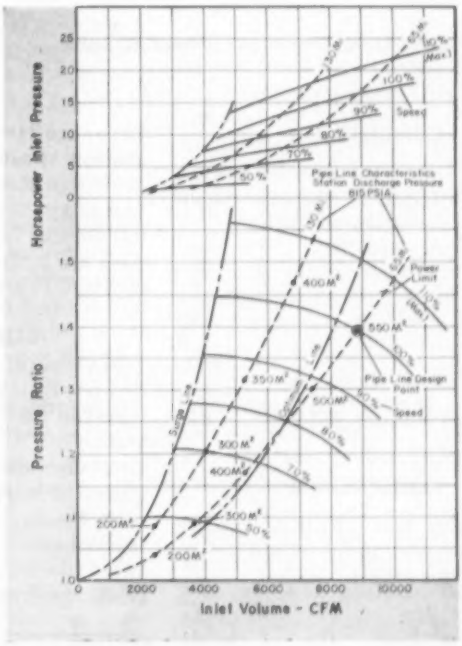


FIGURE 11—Two compressors in series, intermediate design.

Compressor Aids

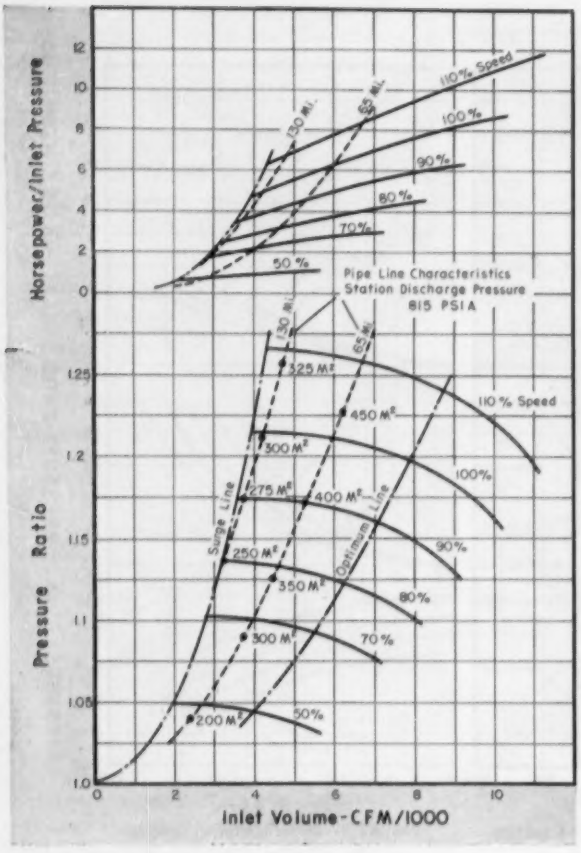


FIGURE 12—One compressor intermediate design.

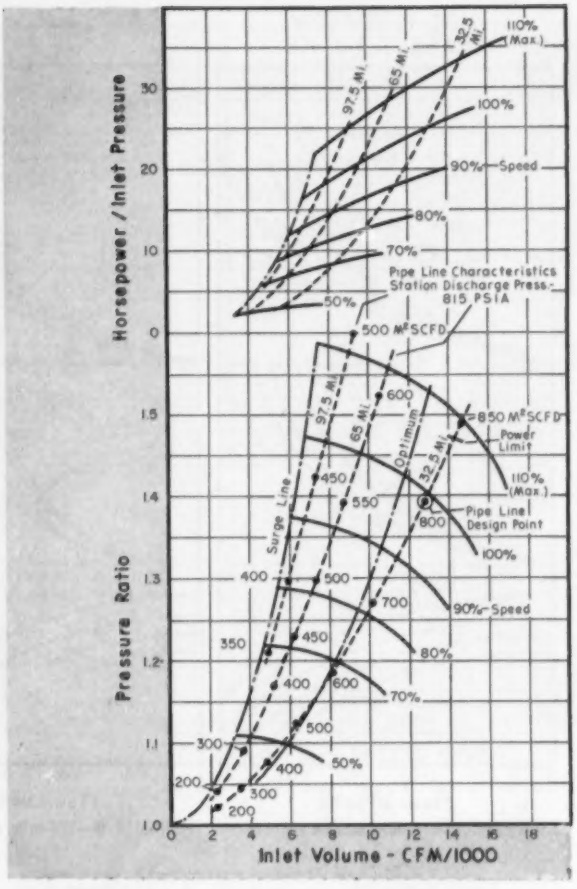


FIGURE 13—Three compressors in series, ultimate design.

CONDITION 1

Maximum Flow-Full discharge pressure attained in the first station following the down station.

Station	A	B
Units operating	0	1
Flow—M²SCFD	..	265
Inlet Pressure—PSIA	..	575
Horsepower	..	4900
Speed	..	110%
Discharge Pressure—PSIA	..	815

CONDITION 2

Maximum flow—Full discharge pressure attained in the second station following the "down" station.

Station	A	B	C
United Operating	0	1	1
Flow—M²SCFD	..	290	290
Inlet Pressure—PSIA	..	520	580
Horsepower	..	5150	5225
Speed	..	110%	110%
Discharge Pressure—PSIA	..	730	815

Intermediate design—65-mile station spacing. For the intermediate design condition with 65-mile station spacing and two compressors per station, two typical emergency operations are again considered using Figures 6, 8, 11 and 12:

CONDITION 1

Maximum Flow—One station down—Full discharge pressure attained in the following station.

Station	A	B
Units Operating	0	2
Flow—M²SCFD	..	417
Inlet Pressure—PSIA	..	530
Horsepower	..	9650
Speed	..	110%
Discharge Pressure—PSIA	..	815

Use the Readers' Service blue post cards on the last page of this issue for more information on advertised products.

CONDITION 2

Maximum Flow—One Compressor down in one station—Full discharge pressure attained in that station.

Station	A
Units Operating	1
Flow—M²SCFD	470
Inlet Pressure—PSIA	649
Horsepower	5450
Speed	110%
Discharge Pressure—PSIA	815

Ultimate design—32.5-mile spacing. For the ultimate design condition with 32.5-mile spacing and three compressors per station, three emergency conditions have been analyzed using Figures 5, 6, 13, 14 and 15.

CONDITION 1

Maximum Flow—One compressor down in two adjacent stations—Full discharge pressure attained in the following station.

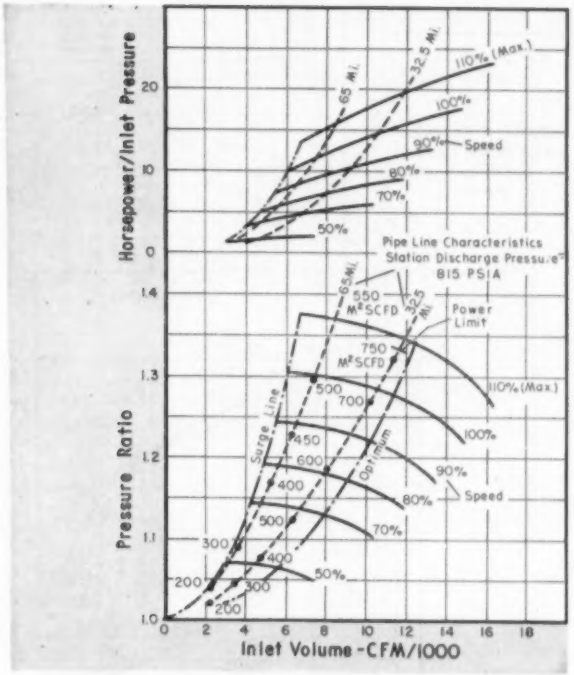


FIGURE 14—Two compressors in series, ultimate design.

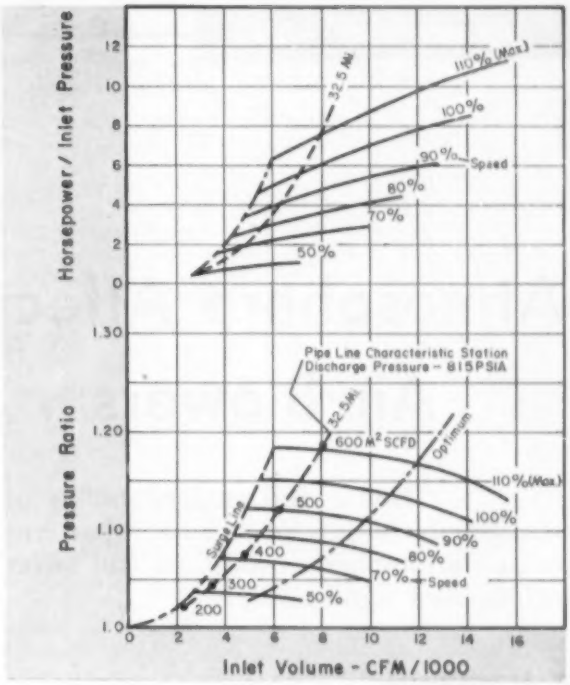


FIGURE 15—One compressor, ultimate design.

Station	A	B	C
Units running	2	2	3
Flow—M²SCFD	775	775	775
Inlet pressure—			
PSIA	600	575	525
Horsepower	11500*	11500	16700
Speed	108.5%	109.5%	109%
Discharge pressure—			
PSIA	798	768	815

*—Maximum.

CONDITION 2

Maximum Flow—Two compressors down in one station—Full discharge pressure attained in the second following station.

Station	A	B	C
Units running	1	3	3
Flow—M²SCFD	740	740	740
Inlet pressure—			
PSIA	621	500	540
Horsepower	5750	16500	16300
Speed	110%	110%	108.5%
Discharge pressure—			
PSIA	728	754	815

CONDITION 3

Maximum Flow—One station down—Full discharge pressure attained in the second following station.

Station	A	B	C
Units running	0	3	3
Flow—M²SCFD	..	650	650
Inlet pressure—			
PSIA	..	468	530
Horsepower	..	14650	14850
Speed	..	110%	109%
Discharge pressure—			
PSIA	..	716	815

All of these unusual operating points are found to fall well within the operating range of the compressor characteristics. A complete analysis of probable emergency conditions such as these must always be included in the compressor selection procedure.

Special points for selecting characteristics. As shown in Figures 10, 11 and 13, the compressor characteristic is usually selected so that the pipe line design point occurs slightly above the optimum flow line for the compressor and at a speed low enough that the overload capacity of the driver may be fully utilized.

This leaves a broad range between normal operation and the stability limit, or "surge line," of the compressor. Most of the reduced load operation occurs within these limits. It is interesting to note that for very low flows in the pipe line, such as might be encountered during line packing, the compressors are farthest from surging when all units in all stations are operated. This is true even though the pressure ratio and horsepower required are very low. Thus, if surging started with only two machines running in a three unit station, it could be stopped by starting the third machine and operating all three at lower speed.

Compressor characteristics selected for this study have moderately sloped pressure-volume characteristics; the best for most installations. Either flatter or steeper characteristics may be appropriate in special case. These can be achieved by adjusting impeller proportions and blade angles. Where constant speed drivers are used, adjustable inlet guide vanes ahead of the impeller can be designed to simulate, to some degree, the effect of varying speeds.

Step-up or step-down gears are used where optimum speeds of compressor and driver cannot be matched satisfactorily. Many other design features are available for special circumstances.

The centrifugal compressor is a "natural" for large, modern pipe lines. It is reliable, efficient, easy to operate and simple to maintain. With good engineering it can be a valuable tool in the business of moving gas to market. ##

Compressor Aids

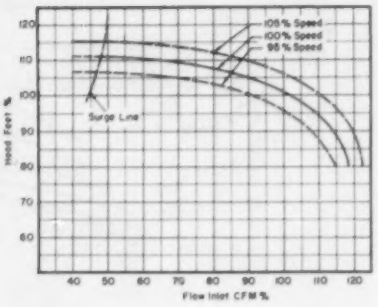


FIGURE 1 — Typical performance curve of a centrifugal compressor.

Atmosphere Affects Air Blowers

Get a full understanding of centrifugal compressor behavior patterns because atmospheric conditions can affect performance significantly.

W. A. Rostafinski
Worthington Corporation,
Harrison, N. J.

This article is intended not only for users of centrifugal air compressors. It will also be helpful to those who have to select such a unit. It may help them to fix the point of maximum efficiency of the performance curve, determine flow and pressure, and to adopt proper basic conditions at suction: pressure, temperature and relative or absolute humidity. The importance of the correct estimation of existing or expected atmospheric conditions, range of operation of the compressor and finally the compressor's essential characteristics, cannot be enough overemphasized.—The Author.

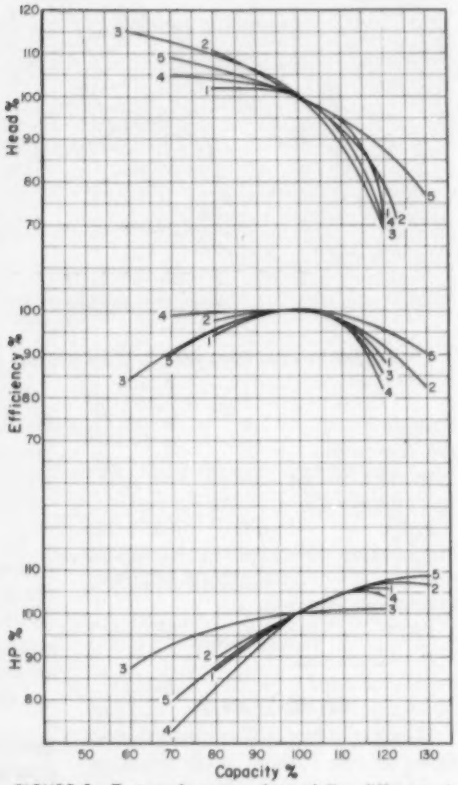


FIGURE 2—Test performance data of five different air compressors. Capacity, head, efficiency and horsepower are expressed in percent of the design part values.

CENTRIFUGAL AIR compressors are applied where large volumes of air are required under moderate pressure. Usually a compressor supplies air at specific conditions of pressure and temperature to a process system which uses it as a raw material. The system is provided with suitable controlling apparatus to make certain that the supply conditions are maintained constant.

The compressor takes suction from the atmosphere which is regarded as a reservoir of infinite capacity. Physical conditions such as pressure, temperature, and humidity of the air are variable. Unlike the case of gas within a reservoir of limited capacity, the temperature of air may vary without affecting its pressure or vice versa.

If, at the compressor inlet, the presence of such devices as filters, washers, etc., is neglected then it may be assumed that the suction is direct from the atmosphere and that the changes in atmospheric conditions will have a definite and direct effect on the compressor performance. These changes could also affect the process operation but the discharge conditions of a compressor are assumed to be kept constant and thereby the process system will be undisturbed.

Unlike a modern multistage centrifugal boiler feed pump, a centrifugal compressor (of similar impeller and diffuser design to a boiler feed pump) has, as shown in Figure 1, rather narrow output limits. If not equipped with adjustable inlet vanes or other means of flow regulation, a compressor can not operate at lower outputs than approximately 50 percent (40-60 percent) of the capacity of its design point. The sensibility to surging determines this limitation. On the other hand, a compressor does not operate beyond about 115 percent of the rated capacity. This limit is fixed by rapid decrease in discharge pressure and in efficiency, thus by uneconomic operating conditions. As shown in Figure 1, the performance curves resulting from increase of speed are shown as dashed lines. The simple, square and cubic relationship of the output, head and power input with the rotational speed of a compressor applies here within small changes of speed.

To predict the performance of a centrifugal compressor under any conditions of operation, a test performance curve, Figure 1, must be available. Only then the formula giving polytropic head and the equation of

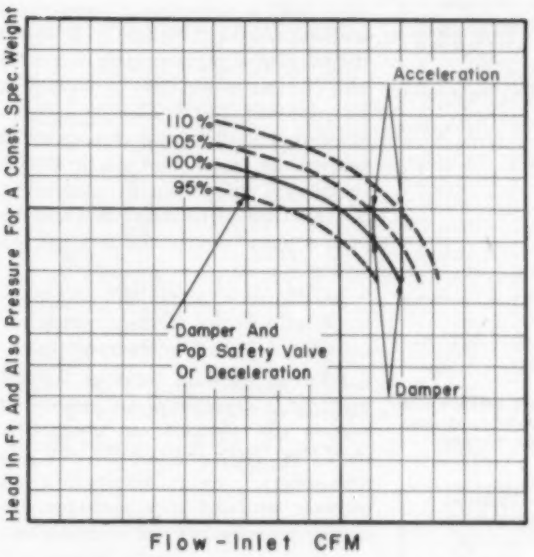


FIGURE 3—Compressor operation with a regulated constant discharge pressure.

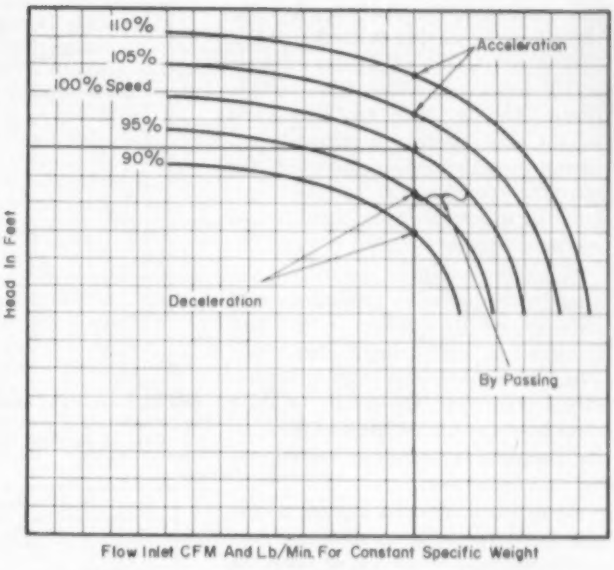


FIGURE 4—Compressor operation with a regulated constant weight flow.

horsepower requirements can be usefully applied. Because the characteristic of a performance curve depends on many factors such as the type of impellers (radial or Francis), type of diffuser, and others, this curve can only be determined from test conducted, preferably by operation at or about the design conditions.

Variations in atmospheric conditions can be quite great as a result of seasonal changes, altitude, and geographical characteristics.

Seasonal changes vary between summer and winter extremes. Between these two seasons the mean temperature difference can be as much as 60 F. This high differential may maintain itself for quite a long period of time.

The absolute humidity of the free air can change from let us say 15 grains of water per pound of dry air in winter to 250 grains or more of water per pound of dry air in summer. This almost 2000 percent change in water content of the atmosphere includes usually a change in the relative humidity of the air, which will be frequently much higher in summer than in winter time.

Daily temperature variations may also vary between quite wide limits. The amplitude is easily some 25 F. and not infrequently 40 F. As for humidity it may vary from 30 to 100 percent of the relative content. Also the pressure variations can amount to ⅓ to ½ inch of Hg. These pressure variations due to atmospheric conditions are of the same magnitude as the pressure drop usually occurring at the compressor inlet, due to presence of filters, washers, and ducts. The apparatus should not create more than about 5 inches of H_2O pressure drop. The 5 inches of water are equivalent to $5 \times 0.0735 = .3675$ inches of Hg. So an additional pressure drop of about ⅓ inch of Hg. due to atmospheric conditions may in some cases be considered important.

The atmospheric variations will influence the performance of a centrifugal air compressor by changing the conditions at its suction. This region is the only place where there is a functional contact of the operating compressor with the ambient air. The conditions at the discharge are usually directly related with the closed system into which the compressor discharges. Were it not for the controls and regulating devices, the discharge conditions would otherwise be altered with changes at compressor inlet.

There are two main types of process systems. A constant pressure system at variable flow rate (Figure 3), and a system requiring a constant weight flow of compressed air at varying discharge pressure (Figure 4). In the constant pressure system a variable quantity of compressed air is required but the process pressure is maintained constant regardless of the input variations. The second type requires a constant amount of pounds of compressed air per unit of time. In this case the discharge pressure will adapt itself to the circuit demands and the required weight flow of air will be delivered.

The first of the two basic systems will be simply regulated by a pop

Meet the Author

W. A. ROSTAFINSKI, a mechanical engineer in Worthington Corporation's Turbomachinery division, prepared his article because he felt that more data on controlled discharge operation of centrifugal compressors would fill a gap in compressor engineering manuals. A native of Poland and a former Belgian resident, he is engaged in setting up thermodynamic and mechanical characteristics for centrifugal compressors, as well as handling some Worthington design and development work. Rostafinski started his technical education in Warsaw, later graduating from Belgium's Louvain University. Before coming to the U. S. in 1953, he was associated with the thermodynamic and heat-engineering activities of a Brussels consulting firm.

Rostafinski

safety valve in the discharge line; by throttling the suction or discharge line and/or by the use of a pressure relay which will modify the drive turbine speed. The second, the constant weight flow system, is seldom completely automatically controlled for constant operation. It can be regulated by means of throttling valve, or by speed change.

Whatever system is considered, the atmospheric pressure variations will have usually little effect on the performance of a centrifugal compressor. The reason for this is that these pressure variations are small. In some cases however the problem of decreasing pressure at suction of a compressor may be serious.

As it was mentioned already a current pressure variation does not normally exceed ⅓ to ½ of inch of mercury. Also it is worthwhile to mention that a compressor designed to operate at sea level if put in operation at 500 feet altitude will have a suction pressure about ½ inch of Hg. lower (exactly .541-inch) than standard sea level pressure.

As shown in Figure 5, in connection with a constant pressure system, when the pressure decreases at the suction, a compressor will have to develop a higher head in order to compensate for the lower specific weight of the air and in order to produce a higher ratio p_2/p_1. The cfm delivered will decrease but the absolute or even relative values of these variations depend on the shape of the respective performance curve, and each compressor must be considered separately.

In connection with a constant weight flow system (Figure 6), for a decrease of inlet pressure, the compressor will have to admit more cfm of lighter air (so same pounds/minute). This will cause the discharge pressure to fall. The horsepower requirement of the compressor can be predicted, only when the characteristic of the performance curve is known.

With a speed regulation (turbine driven compressor or unit with hydraulic transmission) both above cases will result in speed increase and slightly increased horsepower; this last change will be proportional to the cube of speed ratio multiplied by the ratio of pressures (new and previous) at suction.

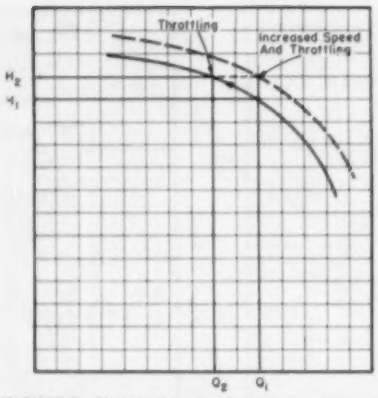


FIGURE 5—Effect of atmospheric pressure drop on performance of a centrifugal air compressor. Case of constant discharge pressure.

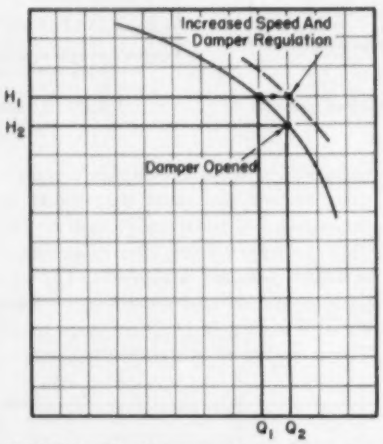


FIGURE 6—Effect of atmospheric pressure drop on performance of a centrifugal air compressor. Case of constant weight flow.

To determine some relative values of these changes (increase or decrease of pressure, flow, horsepower and the like) with a reduction of pressure at suction, consider Figure 7. It shows the relation of pressure ratio as a function of head in feet (H) generated by a compressor. In this case the concept of head is used, instead of pressure in psi, for the reason that the head of a centrifugal compressor is independent of the nature of fluid handled and expresses more clearly the changes occuring.

In Figure 7, three different polytropic efficiencies of compression are considered. It can be observed that:

- For a pressure ratio of 2.8 for example, a decrease in air pressure at suction of 1½ percent (about .42-inch Hg.) from the normal 14.7 psia atmospheric pressure, results in a 1½ increase in head if a constant discharge pressure is to be maintained.
- For pressure ratio of 2.0, the same pressure drop at inlet as stated above, requires a 2½ percent increase in head to compensate for it. Also it must be noted that there is a slight influence of the compressor efficiency on the value of required head change.

A variation of head of 2 percent, for instance, may be of severe consequences. In a compressor having a comparatively flat head-capacity characteristic and driven by a constant speed driver (regulation being done by throttling) this variation may result in surging. With a steeper performance curve such an increase in head is perfectly possible. With a variable speed driver this 2 percent increase in head is of almost no importance as the change in speed re-

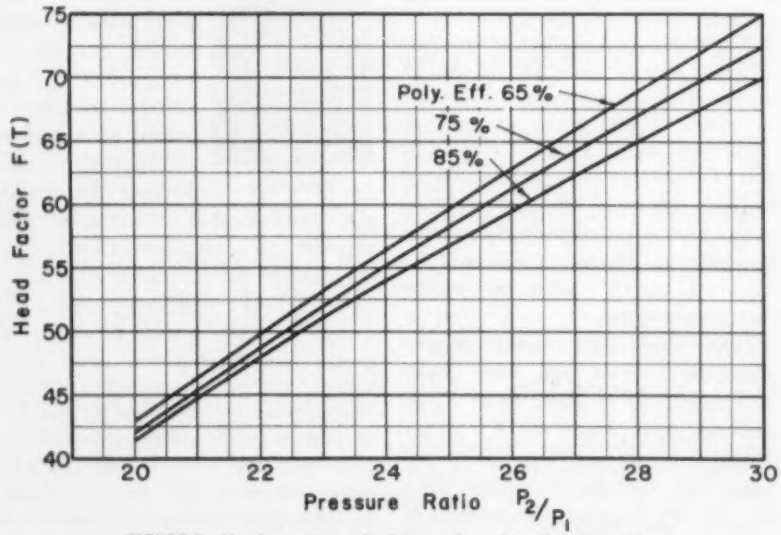


FIGURE 7—Head-pressure ratio diagram for polytropic compression.

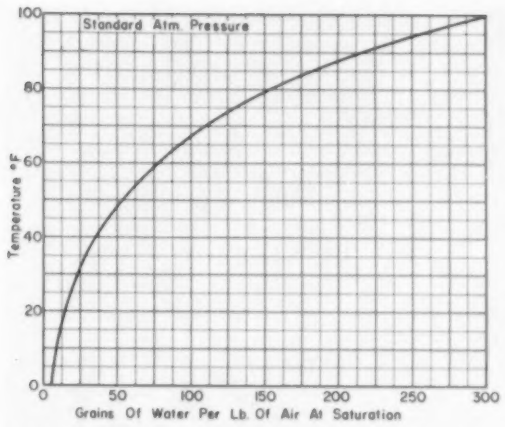


FIGURE 8—Water vapor content of saturated air at various temperatures.

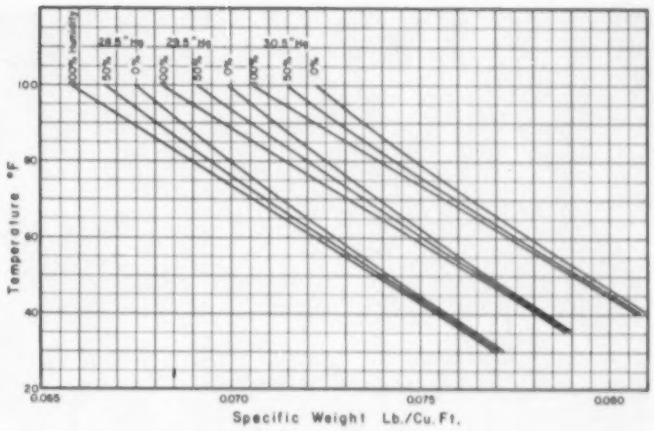


FIGURE 9—Effect of temperatures, pressure, and humidity changes on specific weight of air.

quired is only of the order of $\sqrt{102}$ of the rated speed.

Humidity, the content of water vapor in air, is due to general weather conditions and is a function of the temperature of the air. It is also affected by the atmospheric pressure but to a small degree.

The absolute quantity of water that air can carry (e.i. the content at saturation) is very small in the low temperatures range, quite appreciable with the summer high temperatures (Figure 8).

Before going further, remember that at usual atmospheric pressures...

- The humid air is lighter than the dry air (Figure 9).
- The humid air behaves much more like a perfect gas (pv = RT relationship) than the dry air alone (Figure 9).

What is the influence of this water vapor carried along with air, on the compressor operation?

The influence is double . . .

- First, the specific weight of the fluid is affected and so is the discharge pressure and the horsepower.
- The specific heat of the fluid is somewhat changed; this change is however too small to affect the compression cycle calculations.

Figure 9 shows the effect of humidity on the specific weight of humid air. As numerical example let us choose air at standard atmospheric pressure (29.92 inch Hg.) and at temperatures of 20 and 100 F. (Figure 10). When expressed in percent the change of specific weight of the humid air with a variation of relative humidity is as follows:

Relative humidity change	50%
Specific Weight Change:	
- air at 20° F.	.06%
- air at 100° F.	1.25%

From the above data it must be concluded that a change in relative humidity in winter conditions is without consequences on the compressor operation. In summer however, a variation of 50 percent humidity can be sensed in power consumption.

Consider now the case of interstage cooling. With such an installation the value of the relative and absolute humidity of the air at suction of the first stage has a great importance. With a sensible change in water vapor content in the atmosphere the effectiveness of moisture separation, after intercooling, may be compromised and the second stage compression may follow a changed path.

Consider, for instance, the case of a two-step compression system composed of a first step compressor followed in series by an intercooler, a moisture separator, and a second step compressor. The compressed air requirements are 1000 pound per minute. In summer (100 F. air design temperature at suction) this 1000 pounds of air will be saturated with 42.9 pounds of water vapor. After the intercooler and at the inlet to the second step compressor the air will be maintained at a constant temperature and at a constant pressure of 90 F. and 30 psia respectively. The moisture

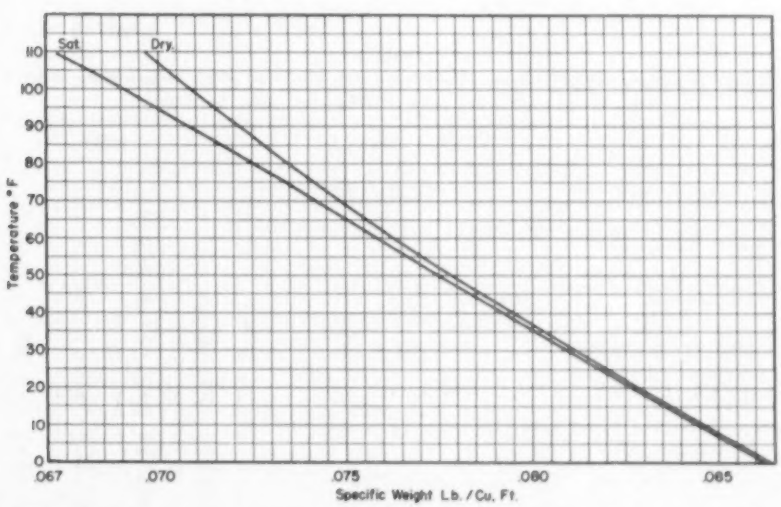


FIGURE 10—Effect of temperature and humidity changes on specific weight of air at standard atmospheric pressure of 29.92" hg.

carried with the air into the second step compressor will amount to 14.8 pounds per minute. The 42.9 - 14.8 = 28.1 pounds per minute of water will be condensed and drained off.

In winter (20 F.) the initial humidity in the air, at saturation, will amount to 2.1 pounds per 1000 pounds of dry air. There will be no condensation in the intercooler. Therefore in summer time a definite volume is being deducted from the inlet to the second step compressor because of condensed water. Under this condition the second step compressor follows a certain pattern.

In winter time, however, with absence of moisture separation no volume deduction occurs on account of the condensed water; the second step compressor will follow a different pattern relationship than it did during summer time operation. Namely, that the second step compressor will operate at a greater volume flow in comparison to the amount discharged from the intercooler during summer operation.

The comparatively greater flow will therefore have an effect on second step compressor operation, and therefore in overall compression of the system.

As the relative humidity change of the atmospheric air occurs most often with simultaneous change of the temperature, the two effects will combine and may result in important changes in the operation of a compressor.

Among all weather factors, the temperature variations certainly have the most important influence on compressor operation. Figures 9 and 10 show, for three different atmospheric pressures chosen, the variation of the specific weight of air (dry, 50 percent humid and saturated) with the temperature. These variations, expressed in percent of design point temperature are tabulated hereafter. It can be seen that a seasonal variation of 80 F., from 0 F. to 80 F., is responsible for a weight flow reduction of 17.4 percent. Also, a variation from 60 F. to 40 F. will increase the weight flow by 3.85 percent.

On the other hand, with a given compressor running at constant speed (the head being a constant quantity) the temperature variation will affect the pressure ratio obtainable. When the temperature variation is greater than say 3 percent, the influence of

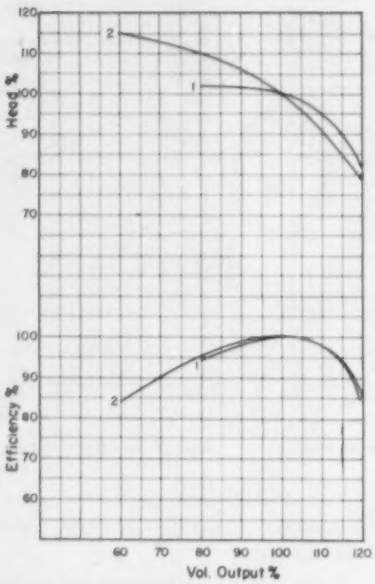


FIGURE 11—Performance curves of two typical centrifugal compressors expressed in percent of the best efficiency point parameters.

the characteristic of the performance curve will be very important. In order to explain this influence, consider the two curves shown in Figure 11. These curves are typical and their shape represents two very different performance characteristics of two centrifugal compressors. Assuming a temperature change which results in 10 percent change in the specific weight of air at inlet, we have to consider the variations of pressure, output and horsepower. See Table 2.

The following can be stated:

1. In connection with throttling in order to maintain a constant weight flow, the horsepower variation with varying temperature of the air will be greater with the increasing temperature than with the corresponding cooling down of the atmosphere.

2. In order to maintain a constant discharge pressure it is necessary to provide the driver with a greater horsepower reserve than it is necessary with a constant weight flow unit, when damper regulation alone is used.

3. A constant discharge pressure system may induce a surging more likely than a constant weight flow regulation (except when the compressor is equipped with adjustable inlet valves).

4. With flow and the discharge pressure kept constant and with a speed and throttling regulation of a centrifugal compressor, the horsepower requirements will be in proportion with specific gravity of the air.

5. No preference can be given to any of the two types of performance curves. In some situations one is more advantageous, than the other, and in the case of speed and damper regulation, there is practically no difference which type is used.

TABLE 1

Variation of specific weight of air with varying temperature (in percent).

ACTUAL TEMPERATURE F	Design Point = 0 F	Design Point = 60 F
−10	2.18	13.5
0	0	11.5
+10	2.18	9.6
20	4.35	7.7
30	6.5	5.8
40	8.7	3.85
50	10.9	1.93
60	13.0	0
70	15.2	1.93
80	17.4	3.85
90	19.6	5.8
100	21.8	7.7

TABLE 2

Change in compressor performance conditions with variation of air temperature at inlet. Note: Design point is expressed as 100 percent value. See Figure 11.

	CURVE			
	1		2	
Absolute temperature at inlet (percent)	110	90	110	90
Spec. weight of air at inlet (percent)	91	111	91	111
Constant Weight Flow (with damper regulation):				
Capacity (lb/min) (percent)	100	100	100	100
Capacity (efm)* (percent)	110	90	110	90
Discharge head (ft) (percent)	95	101.5	91	106
Discharge pressure (psia) (percent)	Can not be predicted here			
Efficiency (percent)	98	98	98	98.5
Horsepower (hp) (percent)	97	103	93	107.5
Constant Discharge Pressure (with damper regulation):				
Discharge pressure (psia) (percent)	100	100	100	100
Discharge head (ft) (percent)	110	90	110	90
Capacity (efm) * (percent)	surging	115.5	80	111
Capacity (lb/min) (percent)	surging	128	73	123
Efficiency (percent)	(94)	94	95.5	97.5
Horsepower (hp) (percent)	....	123	84	113.5
Constant Weight Flow & Constant Discharge Pressure (speed regulation and throttling):				
Capacity (lb/min) (percent)	100	100	100	100
Capacity (efm)* (percent)	110	90	110	90
Discharge pressure (psia) (percent)	100	100	100	100
Discharge head (ft) (percent)	110	90	110	90
Speed required (rpm) (percent)	105.5	94	106.5	93.5
Horsepower (hp) (assumed no efficiency change) (percent)	110	90	110	90

* In terms of suction conditions.

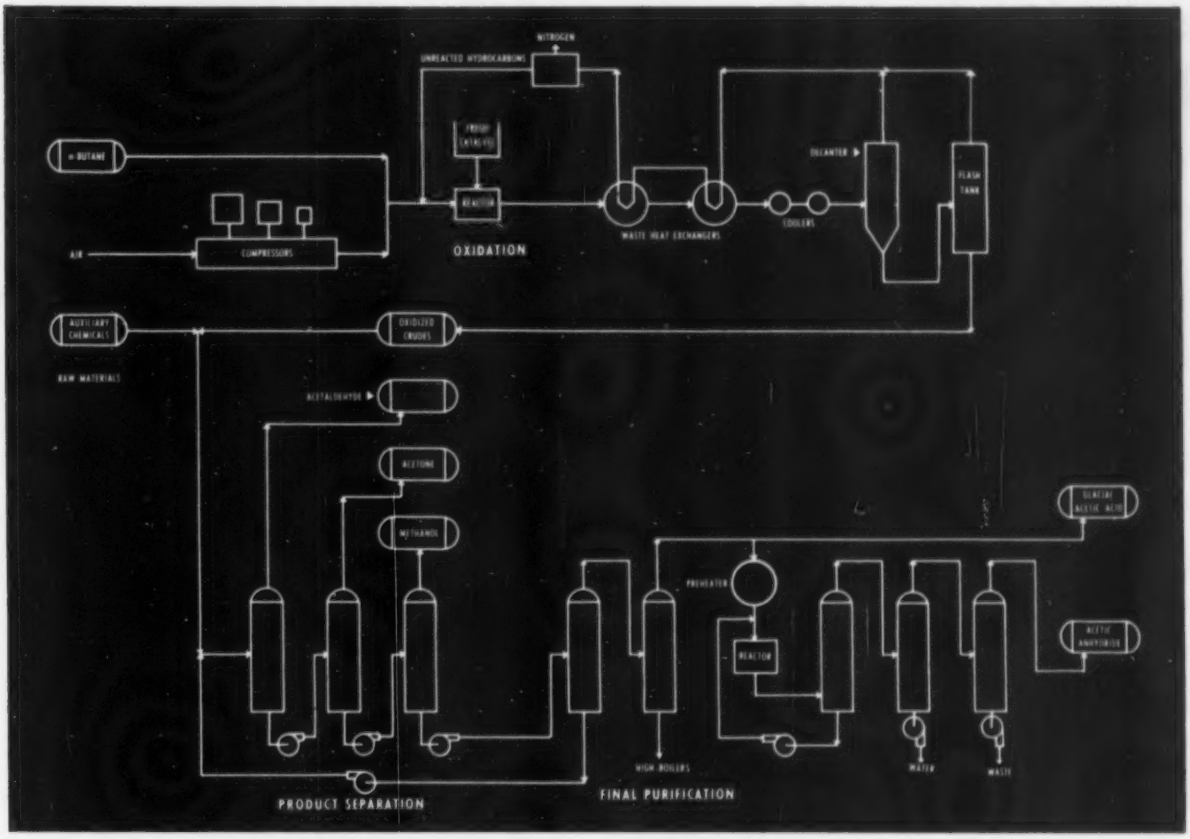


FIGURE 1—Production of acetic acid by the oxidation of butane, Celanese Corporation of America.

Acids and Anhydrides from Petroleum

• Processes • Chemical Reactions • Uses

Lewis F. Hatch
University of Texas
Austin, Texas

ORGANIC CARBOXYLIC acids, $R-\overset{O}{\overset{\|}{C}}-OH$, are neither as well known nor as extensively produced as alcohols, ketones and polychlorohydrocarbons. They and their close relatives, the acid anhydrides, $R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R$, are obtained both directly and indirectly from petroleum. The principal use of acids is to make esters, $R-\overset{O}{\overset{\|}{C}}-OR$, and for this purpose anhydrides frequently can do the same thing and do it better. The simple esters are good solvents, while the polyesters are used as plastics and resins.

There are a number of means available for the production of organic acids and their anhydrides from petroleum raw materials. Most of these routes involve two or three reactions before the desired compound is obtained. The present article will be restricted to those industrial processes which produce acids or anhydrides directly from petroleum hydrocarbons.

Oxidation of Paraffin Hydrocarbons

The oxidation of paraffin hydrocarbons can be conventiently divided into the oxidation of low molecular weight paraffins in the vapor phase and the oxidation of liquid petroleum hydrocarbons. The vapor phase oxidation of propane and butane, both catalytic and non-catalytic, is currently of more interest than the liquid phase oxidation of higher molecular weight hydrocarbons.

Oxidation of Propane and Butane—The non-catalytic vapor phase oxidation of propane and butane between

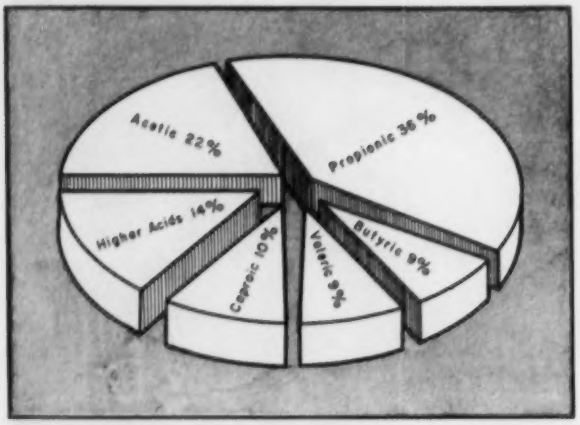


FIGURE 2—Distribution of aliphatic acids from a Venezuelan thermally cracked naphtha (100-400 F.).

350 and 400 C. yields a variety of products of which organic acids are only a minor portion. It is reported, however, that Celanese Corporation of America in its Pampa, Texas, plant is oxidizing butane directly to acetic acid (Figure 1). The by-products are formic acid and butyric acid along with acetaldehyde, acetone, methanol, methyl ethyl ketone and lactones. The method used for this oxidation has not been verified but presumably it is catalytic. The acetic acid is converted to acetic anhydride for making cellulose acetate (Celanese Corp. of America).

Because the non-catalytic oxidation of low molecular weight paraffin hydrocarbons is characterized by the multiplicity of products, there has been an appreciable amount of research on catalytic oxidation to obtain a preponderance of one product. The most successful catalyst has been hydrogen bromide, a catalyst developed by Shell Development Company. In the presence of hydrogen bromide, the character of the product is determined by the most reactive carbon-hydrogen bond. Tertiary hydrogen atoms are the most reactive and primary hydrogen atoms the least. As a consequence of this, a good yield of an acid is obtained only with ethane (63 percent acetic acid). Propane gives primarily acetone (75 percent) with only 8 percent propionic acid and *n*-butane is reported to give 27 percent butyric acid, 21 percent diacetyl

$$\left(\begin{array}{cc} O & O \\ \| & \| \\ CH_3C-&-CCH_3 \end{array}\right)$$

and 30 percent methyl ethyl ketone. Varying amounts of alkyl bromides are also formed. The volume ratio of reactants is usually 2:2:1 of hydrocarbon, oxygen and hydrogen bromide. A temperature range of 150-200 is used.

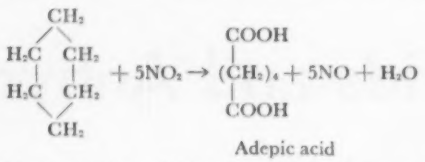
Oxidation of Liquid Petroleum Hydrocarbons—Liquid petroleum hydrocarbons have been oxidized on a commercial scale in the United States since 1926. The quantities involved have not been large because of the complexity of the products. Air oxidation between 200 and 350 C. at 150 to 300 psi with soluble salts of manganese, copper, iron, chromium or vanadium as a catalyst will yield a product consisting of a mixture of 35 percent organic acids and 65 percent alcoholic and ketonic paraffin oxidation products. The ratio of the various products can vary over a wide range, depending on the choice of starting material and choice of reaction conditions.

The composition of the oxidation products is too complex to permit characterization of individual compounds. The acids tend to be aldehydic or hydroxylated. These acids are usually separated from the unoxidized hydrocarbons and the alcohols, aldehydes, ketones and esters by neutralization with a base and extraction of the water soluble soap. Hydroxylated acids can be separated from the fatty acids by extraction with concentrated phosphoric acid. The organic acids are the most desirable product for they are suitable for the production of soaps, fats, esters and solvents or they can be hydrogenated to alcohols which can be used to make detergents. The acid derivatives are used as greases, oil and fuel additives, and surface active agents for use in the preparation of rust inhibitors, wetting agents and plasticizers.

Aliphatic Acids in Petroleum—Aliphatic acids occur in petroleum fractions, but they are not present in sufficient quantities to warrant commercial utilization. The distribution of aliphatic acids which were extracted from a thermally cracked Venezuelan naphtha is given in Figure 2.

Oxidation of Naphthenes (Cycloparaffins)

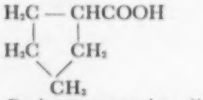
The only commercial oxidation of a naphthene is that of cyclohexane to produce either cyclohexanone or a mixture of cyclohexanone and cyclohexanol (**KA**). The alcohol is subsequently oxidized to cyclohexanone which in turn is oxidized to adepic acid for use in nylon production. The obvious advantage of a process for the direct oxidation of cyclohexane to adeptic acid has been investigated. One such process involves the oxidation of cyclohexane with nitrogen dioxide between 50 and 90 C.



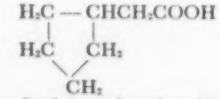
Adepic acid

The yield of adepic acid based on the nitrogen dioxide was reported to be 98 percent at 50 C. after a reaction time of 43 hours. The yields drop off materially with increased temperatures.

Naphthenic Acids—Naphthenic acids are not synthesized but are extracted from petroleum fractions. They are derivatives of cyclopentane and cyclohexane with the carboxyl group attached directly to the ring or separated by one carbon atom.



Cyclopentanecarboxylic acid



Cyclopentylacetic acid

Commercial naphthenic acids are a mixture having a molecular weight range of 180 to 350. They are obtained by caustic extraction of gas-oil and kerosine. The phenols, which are extracted along with the naphthenic acids, are separated from the acids by selective neutralization. Naphthenic acids are dark in color and have an unpleasant odor. They are used in the form of their metal salts with lead naphthenates being the most important. These lead salts are used as components of extreme pres-

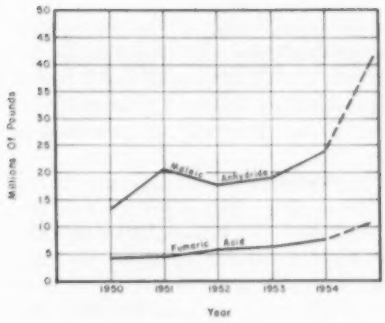


FIGURE 3—Estimated production of maleic anhydride and fumaric acid.

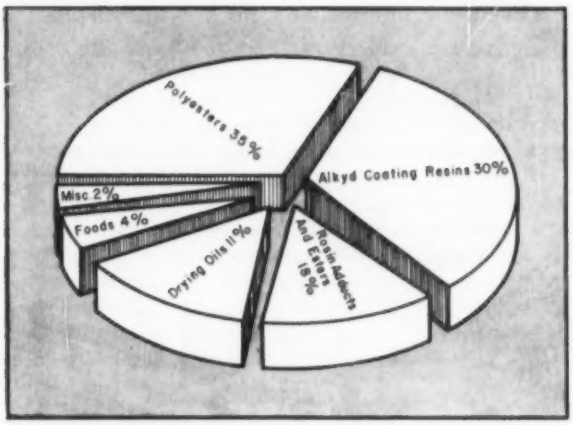


FIGURE 4—Fumaric acid estimated end use pattern.

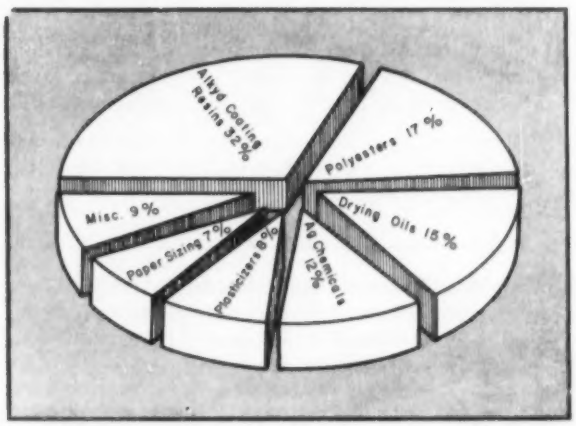


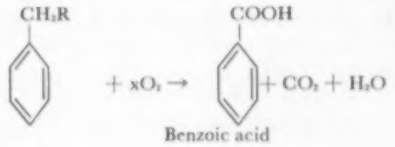
FIGURE 5—Maleic anhydride estimated end use pattern.

sure lubricants and as paint driers along with cobalt and manganese naphthenates. Copper naphthenates are used as wood preservatives and in various paints. Other salts are used in greases and to jelly gasoline. The current annual production of naphthenic acids is 35-40 million pounds, with capacity nearly twice this figure.

Oxidation of Aromatic Hydrocarbons

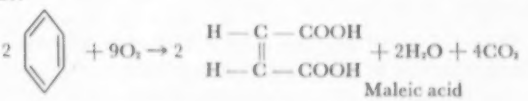
Aromatic hydrocarbons differ materially from paraffin hydrocarbons in their oxidation. They offer several points of resistance to further oxidation, and, as a consequence of this, it is possible to isolate individual oxidation products in good yields. If the aromatic compound has an aliphatic side chain, the oxidation will involve this side chain because of its greater ease of oxidation. This type of oxidation stops at the benzene ring with the formation of aromatic carboxylic acids.

Catalysts are generally used to effect the oxidation at as low a temperature as possible, and, if more than one product is possible, to obtain the desired compound. The predominate product will be determined by the reaction mechanism rather than by free-energy or equilibrium considerations. The oxidation of benzene gives maleic anhydride and a small amount of fumaric acid, toluene yields benzoic acid and ortho-, meta- and para-xylene give phthalic anhydride, isophthalic acid and terephthalic acid respectively.

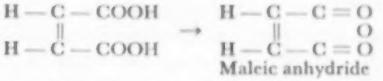


Benzoic acid

Oxidation of Benzene—Benzene is resistant to oxidation, but it can be oxidized catalytically to *maleic anhydride*.



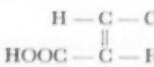
Maleic acid



Maleic anhydride

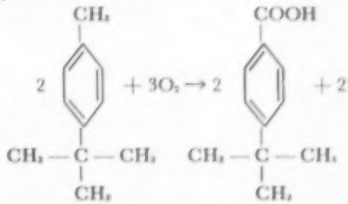
A variety of catalysts has been patented for this reaction, but vanadium pentoxide appears to be the best. It is used as a single-component catalyst supported on an inert carrier. It becomes active at about 300 C., and is at maximum efficiency between 400 and 500 C. The reaction is exothermal, and, once started, maintains itself. The yield of maleic anhydride and fumaric acid is 50 to 60 percent. The ratio of maleic anhydride to fumaric acid is 10 to 1. Production data are given in Figure 3. The total capacity for maleic anhydride production is estimated to be 50 million pounds by the end of 1955.

Fumaric acid is the geometrical isomer *(trans)* of maleic acid *(cis)*.



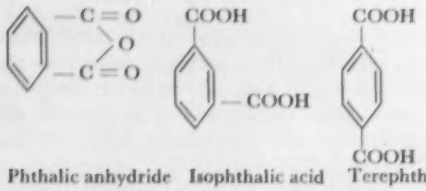
National Aniline Division of Allied Chemical and Dye Corporation, and Monsanto Chemical Company produce fumaric acid as a by-product of maleic anhydride production. It is also produced by fermentation of molasses and by isomerization of maleic acid (Bzura Chemical Company). It is competitive with maleic anhydride in the reinforced polyester resin field (Figures 4 and 5).

Oxidation of Alkyl Benzenes—The oxidation of toluene to benzoic acid would appear to offer an attractive method for the production of benzoic acid. This method is not used, however, for it is more economical to decarboxylate phthalic acid obtained from phthalic anhydride. The only commercial one-step oxidation process to prepare a monocarboxylic acid is that of Shell Chemical Corporation for the oxidation of *p-tert*-butyltoluene to *p-tert-butylbenzoic acid*.



This is a liquid phase reaction using a metallic catalyst. The acid is used as a vegetable oil "upgrader" in surface coating applications of alkyd resins. It has many other potential uses.

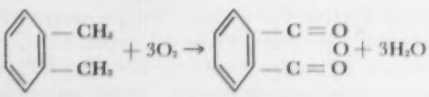
The three xylenes, ortho, meta and para, are oxidized to the corresponding dicarboxylic acids.



Phthalic anhydride Isophthalic acid Terephthalic acid

Phthalic anhydride and terephthalic acid are of considerable industrial importance.

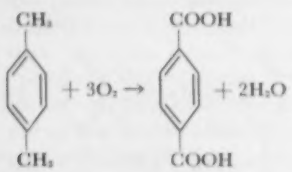
Phthalic anhydride has been a basic raw material for the production of alkyd resins and plasticizers from vinyl and nitrocellulose resins for many years. Until recently the anhydride was made exclusively by the oxidation of naphthalene from coal tar. The increased production of aromatics by catalytic reforming processes has now made ortho-xylene available, and phthalic anhydride is fast becoming a petrochemical.



The oxidation follows that of naphthalene closely with vanadium pentoxide as a fixed-bed catalyst, and a temperature range of 350 to 450 C. The following reaction conditions are of importance: nature and form of catalyst, temperature, air/hydrocarbon ratio and contact time. Careful adjustment of these conditions is important to minimize by-product formation. Over oxidation yields maleic anhydride, carbon dioxide and water. Insufficient oxidation will result in a low conversion plus intermediate oxidation products such as tolualdehyde.

The use of ortho-xylene as a raw material for phthalic anhydride production has several advantages over naphthalene. Ortho-xylene requires less oxygen (air) for its oxidation and there is a lower heat of reaction. There are also less purification difficulties. At present ortho-xylene accounts for about 15 percent of phthalic anhydride production, but its greater reliability and independence of supply will assure a steady increase in its use.

A typical xylene fraction from a petroleum source will contain 21 percent ortho-xylene, 50 percent meta-xylene, 19 percent para-xylene and 10 percent ethyl benzene. The ortho-xylene is separated by distillation, and the rest of the compounds of the mixture are separated by a crystallization process. The para-xylene is oxidized to *terephthalic acid*.

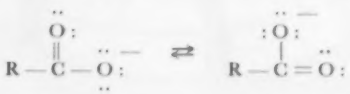


The terephthalic acid is purified as its dimethyl ester and used to make synthetic fibers of the glycol-terephthalate type (Dacron) and film (Mylar). The importance of terephthalic acid is directly related to the public acceptance of these products. It has been estimated that 100 million pounds of para-xylene will be produced in 1955.

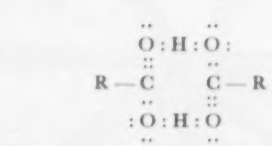
Meta-xylene is the orphan of the xylene family. It can be oxidized to *isophthalic acid*, but as yet no one has stepped forward to claim the child. It can also be oxidized to maleic acid in yields comparable to those obtained from benzene, but meta-xylene is more expensive than benzene. The utilization of isophthalic acid is a relatively unexplored field pregnant with possibilities.

Chemical Properties of Acids and Anhydrides

Organic acids are characterized by containing a carboxyl group, $-\overset{\overset{O}{\|}}{C}-OH$. This group has several unique properties such as partial loss of the double bond character of the carbonyl group, $-\overset{\overset{O}{\|}}{C}-$, and the fact that the carboxylic acid ion exhibits resonance.

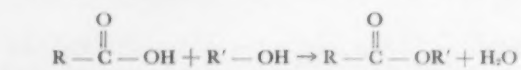


A comparison of the physical properties of organic acids with those of other organic compounds of similar molecular weight shows a striking difference in boiling points. Organic acids boil much higher than corresponding hydrocarbons and even higher than the corresponding alcohols. This increase in boiling point is caused by a tendency of acids to associate and form double molecules.

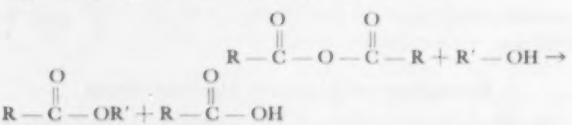


Organic acids are seldom produced for end product uses, because their most obvious property, that of being an acid, can, in general, be duplicated by mineral acids and at a lower cost. Organic acids are very weak acids because of their slight ionization. Acetic acid, for example, has an ionization constant of 1.86×10^{-5}.

The principal use of aliphatic acids is to produce esters



Because this is an equilibrium reaction, the corresponding acid anhydride is frequently used.



The by-product acid can be converted to the anhydride; thus complete utilization is realized. In the field of esterification, an anhydride can do everything an acid can do and usually it can do it better. ##

How Contaminants Influence Design

Contaminants present in process fluids may have a direct effect on process design and also make a given process uneconomical. Specific examples are included.

B. J. Mayland
Robert M. Reed
Norman C. Updegraff
The Girdler Company, Louisville

IN THE PROCESS design of a chemical or petroleum processing plant it is customary to think largely in terms of the major operations to be performed, whether they are reactions, changes in phase, separations or one of many other common operations. Since many of these operations do not go to completion, a cleanup operation such as distillation is frequently required to purify the desired product before it can be sold or used for the next processing step. In all of these operations the emphasis in design is placed on the major constituents of the process streams since these will determine the equipment size and the quantities of utilities needed to heat or cool them or transfer them from step to step; in short, the economics of the process. It is a process engineer's job to select the most effective and efficient of these operations and combine them in such a way as to insure a well integrated plant, low in cost, economical in operation and capable of sustained production of a uniform product. Unfortunately, the best plant that the process engineer can design by use of these process steps may be inoperable or at least troublesome if the effects of process stream impurities and contaminants present or introduced inadvertently have not been thoroughly considered in advance. It is the purpose of this paper to bring this problem out into the light and to illustrate it with a number of examples found in the industry since it is a subject not normally dealt with in engineering texts.

Synthetic Ammonia Plant—Since the possible examples covered by this subject are so numerous, it is necessary to limit this discussion to a few that may be typical. In presenting them, the authors thought it might prove more interesting to relate them all to one design problem rather than select them from the industry at random. Accordingly, the design of an ammonia synthesis plant has been chosen as an example. Since many of the problems are common to other fields it is not felt that this will limit the interest to the ammonia production field.

In considering an ammonia plant, the process engineer may first be introduced to the problem in a number of different ways. He may be given a by-product stream rich with hydrogen such as coke oven gas or a refinery stream such as produced by hydroforming or other processes. On the other hand he may be given his choice of raw materials and told to work up the most economical design he can for a given production capacity. This is not too soon for the process engineer to start considering the effect various impurities present in the streams may have on his design since the problems associated with

Meet the Authors

BERTRAND J. MAYLAND, now with The Girdler Company, previously was with Phillips Petroleum Company as a senior chemical engineer in the Research Department at Bartlesville, Okla., where he worked with problems in process engineering, process evaluation and pilot-plant development. Also while at Bartlesville, he taught evening graduate courses in chemical engineering through Oklahoma's A & M College's Extension Service. A graduate of the University of Wisconsin, Dr. Mayland received his M.S. and Ph.D. degrees from the University of Illinois.

NORMAN C. UPDEGRAFF, assistant technical director of The Girdler Company's Gas Process division, has been with the company since 1946, specializing in process design of plants for producing, purifying and using industrial gases. A Harvard graduate with a degree in engineering sciences, he previously was with E. I. Du Pont de Nemours & Company four years as production supervisor of neoprene manufacture. He is a contributor to the *Encyclopedia of Chemical Technology* and author of several articles on industrial gases.

ROBERT N. REED is technical director of The Girdler Company's Gas Processes Division. Assigned to the division since he joined the company in 1938, Dr. Reed has served successively as chemist, chief process engineer, chief chemical engineer and technical director. During this time he has engaged in process development, design and operation in the fields of acid-gas removal by amine scrubbing, hydrogen and ammonia production, the manufacture of liqiud and solid carbon dioxide and gas dehydration. He is a graduate of the University of Washington.

them may be different with each stream.

Contaminants in Feed Gas—First assume that the ammonia plant is to employ the steam-hydrocarbon process for producing the hydrogen required. In this process a suitable hydrocarbon stream is reacted with steam at 1600 to 1800 F. over a nickel catalyst. Since the reaction is endothermic, it is carried out in alloy steel tubes suspended in what is known as a "reformer" furnace. Heat is supplied by burning more hydrocarbons in the combustion chamber surrounding the tubes. The nickel catalyst used in this operation is sensitive to sulfur in that excessive quantities will cause it to loose activity. Although the catalyst will recover when the sulfur is removed, loss of activity would cause loss of production. Thus the process engineer must provide means of removing this contaminant. If the feedstock is pipe line natural gas, the sulfur quantity is generally less than 5 grains per 100 cubic feet and can be removed successfully by means of activated carbon, caustic solutions or other means. Sometimes the sulfur is in the form of a mercaptan odorant which is added to the gas by the distributing company. In one case involving the production of hydrogen this odorant was added at a continuous rate regardless of gas consumption. Thus, during the night when the heating load was low, an exceptionally high quantity was present in the gas. As a result the activated carbon used for removing it soon became saturated and allowed sulfur compounds to pass through to the catalyst. Until the cause of this was discovered and corrected, considerable production time was lost.

The moral for the process engineer here is to be sure that adequate sulfur removal facilities are provided to take care of conditions beyond the normal. Being sure that the activated carbon beds are large enough to permit one to be regenerated while the other protects the catalyst is good insurance. In another instance involving the production of utility send-out gases, the activated carbon became saturated with alcohol that had remained in the gas line after some drying operations. It is not known how to design against things like this, but it is another example of how contaminants can upset a plant's operations.

If the feedstock is refinery gas rather than natural gas, it may be necessary to remove larger quantities of sulfur compounds than are found in pipe line gas. One method is to employ the Girbotol process in which hydrogen sulfide is removed by a recycling solution of ethanolamines. Here the contaminants present may have a marked effect on the process design since one of the common constituents of refinery gas is carbonyl sulfide, COS. Although generally present in small quantities, it can soon make the desulfurization process inoperative if the wrong amine is selected. This compound will react with monoethanolamine to form a urea derivative which is not broken down in the reactivator. Thus, in a short time the ethanolamine is fixed, its alkalinity gone and desulfurization stops. The solution to this problem is to employ the secondary amine, diethanolamine, which has proven to be resistant to this reaction. It is not enough, however, to merely switch amines after the trouble is found since the secondary amine has a lower capacity for hydrogen sulfide and more must be circulated to effect the same removal of sulfur. This involves larger equipment and greater utilities consumption. Thus, the process engineer must recognize this problem in advance and design the sulfur removal equipment accordingly.

Contaminants in Fuels—The steam-hydrocarbon process, in common with many chemical and petroleum processes, is a high temperature operation where heat is supplied by combustion. Since the cost of the fuel is an appreciable factor, the use of the cheapest source of heat must be considered. Economically the use of a heavy fuel oil such as No. 6, commonly known as Bunker C, would appear to be most attractive, particularly as a standby fuel when gas supplies are low. Although, its characteristics do not make Bunker C the easiest fuel to handle, this is only a small problem of process design.

Of more significance are the deleterious effects of the various impurities found in these residual fuels when employed in high temperature operations. In particular the vanadium and sulfur present in the fuels has been found to cause serious corrosion of boiler superheaters and reformer furnace tubes when operating at temperatures above the melting point of vanadium pentoxide, 1274 F. With metal temperatures lower than this no appreciable corrosion has been observed from firing Bunker C fuel oil.

With higher metal temperatures, a liquid slag containing vanadium pentoxide coats the metal surfaces and apparently fluxes the protective oxide film on the metal, permitting further oxidation and also attack by sulfur compounds. Sodium compounds in the oil, such as salt, vaporize on combustion and react with sulfur dioxide in the flue gases to produce sodium sulfate. A mixture of sodium sulfate and vanadium pentoxide has been found in the furnace ash deposits in cases in which serious corrosion has occurred. The vanadium oxide causes deterioration of iron and chromium while the sulfate attacks the nickel of the alloy.

An example of this was found in an Egyptian ammonia plant where type 310 stainless steel reformer tubes failed in four months time due to the use of Bunker C oil as fuel. The operating temperature of these tubes was in the neighborhood of 1600-1800 F.

Some of the problems encountered in boiler plant operation have been reported by Tibbetts et al in a paper presented before the ASME.[4] One example given is the failure of high nickel steam superheater tubes operating at 1300 F. No trouble had been encountered when firing producer gas, but tube failures occurred within four months after fuel had been changed to Bunker C oil. Analysis of scale from one of these corroded tubes showed 0.15 percent vanadium. Corrosion was confined to those areas where more or less direct impingement of the ash had prevailed.

The effects of this problem on process design are largely in the choice of fuel used. For example the Egyptian ammonia plant problem was solved by switching to a lighter fuel oil since it was not feasible to reduce the operating temperature. In some cases the extra cost of a higher grade fuel could conceivably affect the economics of the process considerably. In such cases the process engineer may wish to investigate the use of other alloys, the possibility of metallizing the tubes, or the use of refractory sleeves to protect them. The use of fuel oil additives to reduce the

corrosive effects of these contaminants should also be considered. Some information on these aspects of the problem has been published by Monkman and Grant.[2] Additional references are also cited in that work.

Impurities from Atmosphere—In the synthesis of ammonia, nitrogen is required as well as hydrogen. This is generally supplied by introducing air or flue gases although in plants where oxygen is required for partial oxidation operations the by-product nitrogen from the air separation plant may be used.

When air is used care must be taken that contaminants present in the plant atmosphere due to neighboring chemical operations be considered and the air intake placed to minimize the possible effects. This, of course, will vary from plant to plant. One constituent of air that is always present, however, is argon. Although this only amounts to about one percent of the air by volume, it has a pronounced effect on ammonia plant operations since it will accumulate in the gas recycling system around the ammonia synthesis converter and reduce the partial pressure of the nitrogen-hydrogen mixture to the extent that the production rate will be reduced.

Thus, it becomes necessary to purge this gas out of the system along with any other inerts, such as methane, that may be present. This purge is controlled to maintain the most economical concentration of inerts in the system but since it is rarely desirable to allow the concentration to exceed 10 percent by volume, synthesis gas is necessarily lost at the same time. This loss is sufficiently high that the process engineer must allow for it in his design. Extra synthesis gas production and compression capacity must be built into the plant to offset these losses.

The effect of this inert on the allowable space velocity in the synthesis catalyst and thus the entire size of the cycling system must also be considered. Thus, the over-all effect of argon in the air is to increase the capital and operating costs of the plant.

When flue gases are employed for nitrogen addition the source must be inspected. Since most flue gases contain residual oxygen, it is desirable to pass them over a primary reforming catalyst along with the steam and hydrocarbon or introduce them upstream from a secondary reforming operation in order to remove this oxygen. At the same time oxides of nitrogen that may be present in the gas stream are destroyed. If the presence of these constituents was not recognized by the process engineer he would probably be inclined to introduce the flue gas downstream from all reforming operations since the major impurities, carbon dioxide and water vapor, would normally be removed in subsequent purification operations. Since these flue gases are to be passed over the reformer catalyst additional factors enter into the design problem.

If the gases result from the combustion of solid fuels fly ash must be guarded against lest it plug up the catalyst bed. If the fuel contains sulfur, the flue gases may prove detrimental to the reformer catalyst as described earlier. Thus, what may at first appear to be the most economical or readily available source of nitrogen may prove to have hidden pitfalls in the form of contaminants not normally considered.

Contaminants from Water—In ammonia plant operation considerable quantities of cooling water are required at various points in the cycle. In order to reduce the cost of cooling equipment, it is often expedient to use a direct contact cooler instead of a tube and shell type. Here is another opportunity for contaminants to enter the system that should be considered by the process engineer. For example, several of the larger ammonia plants in this country employ the Girbotol process for removing carbon dioxide from the raw synthesis gas.

This operation follows the carbon monoxide conversion step which is conducted at 750 to 800 F and thus the gas must be cooled down prior to carbon dioxide removal. In several instances this cooling operation has been performed in a direct contact cooler where the raw synthesis gas picked up dissolved or occluded oxygen from the water. This oxygen then reacted with the ethanolamine in the unit to form corrosive products which soon caused failures in the heat exchange equipment. The process engineer has his choice in this case of deaerating the cooling water to eliminate the source of oxygen or using indirect type coolers which would effectively keep this contaminant out of the synthesis gas stream.

A second example of contaminants being introduced by water is the possibility of introducing chlorine or other water treating chemicals. The introduction of chlorine by means of water used for carbon dioxide removal is described further below.

Contaminants from Lubricating Oil—Since the ammonia synthesis reaction is carried out at pressures ranging from 200 to 1000 atmospheres, reciprocating compressors are required to boost the synthesis gas to this pressure. In addition, a reciprocating compressor is generally used to recycle the gas in the synthesis loop. The lubricants in these compressors may contaminate the gas stream not only with oil, but also with the various impurities in the oil. These contaminants may seriously reduce the activity of the ammonia synthesis catalyst and if not easily removed, allowance for their presence must be made in the plant design. Filters are generally employed to remove entrained oil and as further insurance the process engineer is advised to introduce the makeup gas into the synthesis loop upstream from the ammonia condenser so that the impurities will be washed out of the gas and leave with the product even though some savings in equipment could be effected if the gas were introduced just upstream from the converter. In spite of these precautions, however, some catalyst contamination has still been observed. Slack and his co-workers have described these effects as found at the Tennessee Valley Authority ammonia plant at Wilson Dam, Alabama.[3] Here the contaminants included sulfur and phosphorus from compressor lubricating oil and chlorine from treated water used in the carbon dioxide scrubbers. The amounts of sulfur, phosphorous and chlorine that enter a converter are difficult to determine. However, the quantities that accumulated over a period of 8½ years have been tabulated as shown in Table 1.

The most significant increase is the quantity of sulfur which has been found by experiment to be one of the more severe and permanent poisons.

The effect of these contaminants on process design aside from the obvious necessity of employing lubricating oils with low sulfur and phosphorus contents, and the design of

adequate filters for oil removal, is the necessity of employing sufficient catalyst and synthesis loop capacity to offset the loss in production as these poisons accumulate over a period of time and reduce the catalyst activity. Otherwise, frequent and expensive shutdowns for catalyst replacement will result.

Effects of Incomplete Synthesis Gas Purification—Since almost all raw ammonia synthesis gases regardless of source contain carbon oxides and water vapor, the problem of their removal is well known in the industry. During normal operation of the various processes used, only negligible quantities of carbon oxides or water enters the synthesis catalyst. However, upsets in operation may cause larger influxes for short periods of time. Normally, these components are regarded as temporary poisons but permanent losses in catalyst activity may be caused if the quantities become excessive.

At the pressures used for ammonia synthesis there is little danger of excessive water vapor building up except from carryover due to misoperation or poor equipment design.

In the case of the carbon monoxide, the process design becomes more important as quantities higher than 10 parts per million are generally not tolerable. The bulk of the carbon monoxide present in the raw synthesis gas is removed by reacting it with steam over a water gas shift catalyst to convert it to carbon dioxide. One or more stages of conversion each followed by carbon dioxide removal may be used. After the bulk of the carbon monoxide is removed, the residual quantity can then be removed by condensation, by scrubbing with a copper liquor solution or by methanation; methanation being reaction of carbon oxides with hydrogen over a catalyst at elevated temperature to produce methane.

Although not considered as a catalyst poison, the presence of carbon dioxide in the synthesis loop results in the formation of ammonium carbamate which deposits in the equipment and plugs up the gas filters. The bulk of the carbon dioxide may be removed either by employing ethanolamine solutions or by scrubbing with water at elevated pressure. In some cases caustic solutions are used to remove residual carbon dioxide following this operation. The choice of these processes may in part be determined by whether pure carbon dioxide is desired as a by-product, such as for the production of urea or dry ice, since carbon dioxide from water scrubbing operations will be contaminated with hydrogen and nitrogen. This is another example of how contaminants can affect process design.

Typical Design Problem in Synthesis Gas Purification—As has been indicated above, process design is inseparable from production economics. In designing a process for removing impurities from the crude ammonia synthesis gas the economic factor must be considered. As an example consider the purification of a crude synthesis gas prepared by the partial combustion of natural gas with air which produces a gas containing not only carbon oxides but nitrogen in excess of that required for the proper synthesis mixture.[1] The processing scheme to be used could consist of carbon monoxide conversion, carbon dioxide removal, methanation of residual carbon monoxide and carbon dioxide, and removal of the excess nitrogen together with part of the inert gases by low temperature condensation.

The question arises as to whether to use one or two stages of carbon monoxide conversion and carbon dioxide removal. With low temperature separation employed to remove excess nitrogen the inerts are reduced to the same low level in both cases, thus the only apparent advantage of the two stage operation would be more efficient utilization of the raw synthesis gas as reflected in process gas, process fuel and electric power costs. Disadvantages would include higher steam and cooling water requirements and additional capital investment. Accordingly, energy and material balances are made and the required utilities and raw materials tabulated for the two cases as in Table 2.

As may be seen two stage operation effects savings in process gas, process fuel and electric power. However, higher steam and cooling water requirements more than offset these so that there is no net saving in operating cost to balance against the added investment of a second stage. Therefore, it must be concluded that two stage operation is undesirable in this instance.

In processing schemes not employing low temperature separation, the choice of one or two stages of conversion would affect the inert content of the purified synthesis gas. This would give two stage operation an added advantage. However, the magnitude of this advantage in turn depends upon the tolerance of the synthesis cycle to inerts, this depending in turn on whether high, intermediate or low pressure is used in the cycle.

The above example illustrates how economics are an important consideration in the process engineer's choice of processing steps for removing impurities. Many other examples can be pointed out especially in catalytic processes where the cost of removing impurities must be balanced against the savings in operating or catalyst replacement cost. There are no general rules that can be followed and most often the analysis is not as clear cut as in the above example. Since the result of an economic analysis is dependent upon the price structure used, applying the results to other situations should be done with care.

Original presentation was before the American Institute of Chemical Engineers at Springfield, Mass., May 16-19, 1954.

TABLE NO. 1

Description of Sample	POISONS ACCUMULATED IN USED CATALYST PERCENT		
	Cl	P	S
Used catalyst (8½ years)			
From top of bed	0.05	0.01	0.06
From bottom of bed	0.01	0.02	0.02
Composite of bed	0.01	0.01	0.03
New catalyst	0.02	0.005	0.005

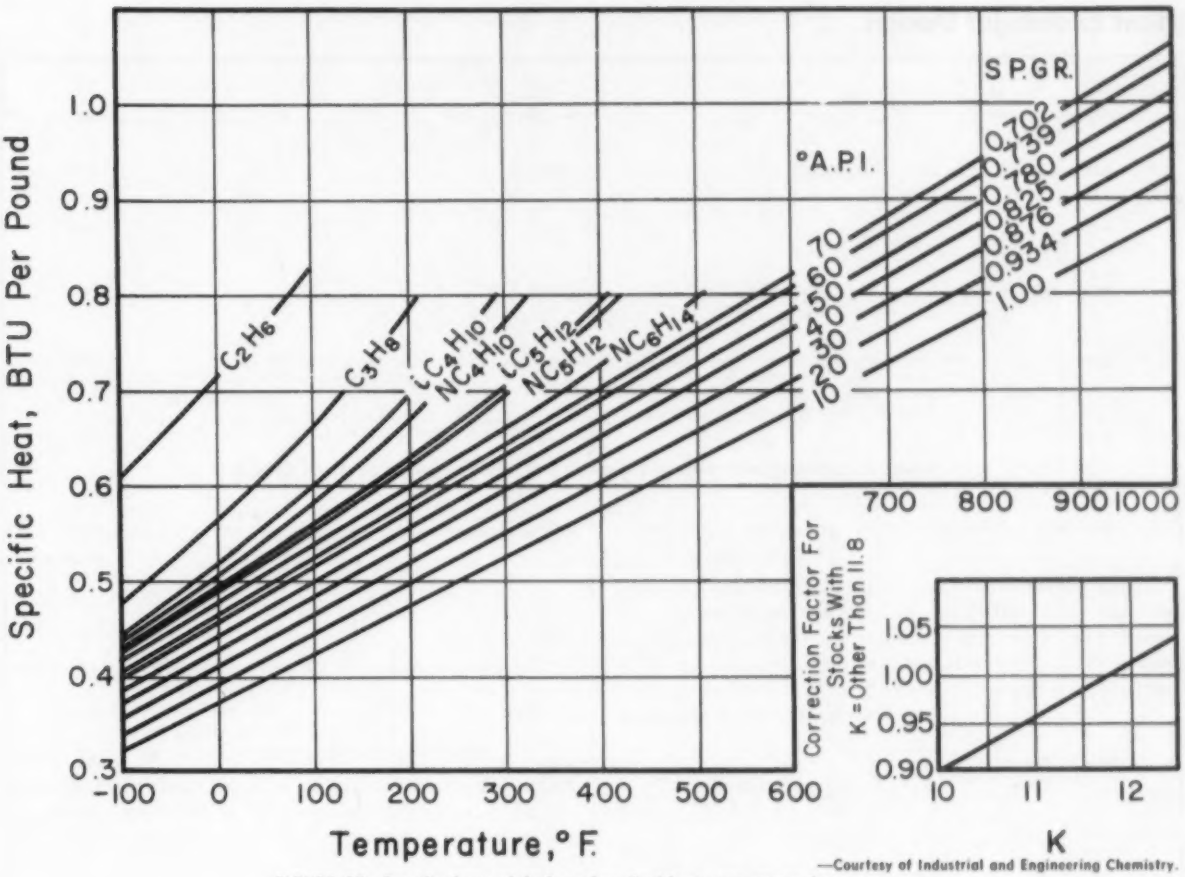
TABLE NO. 2

Utility and Raw Material for NH_3 Production

	ONE STAGE		TWO STAGE	
	Quantity/ Ton	$/Ton	Quantity/ Ton	$/Ton
Natural Gas at 22c/ MSCF:				
(a) Process Gas	27.9 MSCF	$ 6.13	26.3 MSCF	$ 5.78
(b) Process Fuel	3.3 MSCF	.73	3.1 MSCF	.68
(c) Steam Generation	5.2 MSCF	1.15	8.4 MSCF	1.85
Cooling Water, 1.5c/M gal.	56.3 M gal	0.84	66.2 M gal	.99
Electric Power, 0.6c/kwh	917 kwh	5.50	897 kwh	5.39
		$14.35		$14.69

REFERENCES CITED

[1] Mayland, B. J. et al. "Economic Evaluation of Several Processes for the Production of Ammonia Synthesis Gas from Natural Gas." Paper presented at San Francisco meeting A.I.Ch.E. September, 1953.
at San Francisco meeting AIChE September, 1953.
[2] Monkman, F. C., and Grant, N. J. *Corrosion* **9**, 460 (1953).
[3] Slack, A. V., et al, *Chemical Engineering Progress*, **49**, 393 (1953).
[4] Tibbetts, E. F., et al Paper No. 50-A-136 presented at Annual Meeting, ASME November 26-December 1, 1950.



—Courtesy of Industrial and Engineering Chemistry.

FIGURE 15—Specific heat of hydrocarbon liquids at one atmosphere pressure.

Heat Exchanger Design

Part 1: Types and Arrangements

Part 2: Heat Transfer

Part 3: Fluid Flow and Thermal Design

Part 4: Mechanical Design

Daniel A. Donohue, Chemical Construction Corporation, New York

For a real understanding of heat exchanger design, there is no substitute for a working knowledge of heat transfer. In this Part II, chart solutions are presented for temperature difference, Δt correction factor, and coefficient of heat transfer. Types and arrangements of heat exchangers were discussed in Part I of this series (PR, August).

Thermal Design, Basic Equation—The relation governing heat transfer in exchangers is

$$q = UA\,\Delta t \qquad (14)$$

where A = effective external tube surface, sq. ft.
q = heat transferred, Btu/hr.
U = over-all coefficient of heat transfer, Btu/(hr.)(sq. ft.)(°F.)
Δt = effective temperature difference, °F.

For a liquid being heated or cooled

$$q = w\,c_p\,(T - t) \qquad (14A)$$

where c_p = specific heat of fluid at average temperature, Btu/(lb.)(°F.)
t = lower temperature, °F.
T = higher temperature, °F.
w = rate of flow, lb./hr.

q, the duty required to be performed by the exchanger, is known at the outset. A chart giving values of specific heat of hydrocarbon liquids is shown in Figure 15.[1]

Temperature Difference—For the case of two fluids in either parallel flow or counterflow the effective tempera-

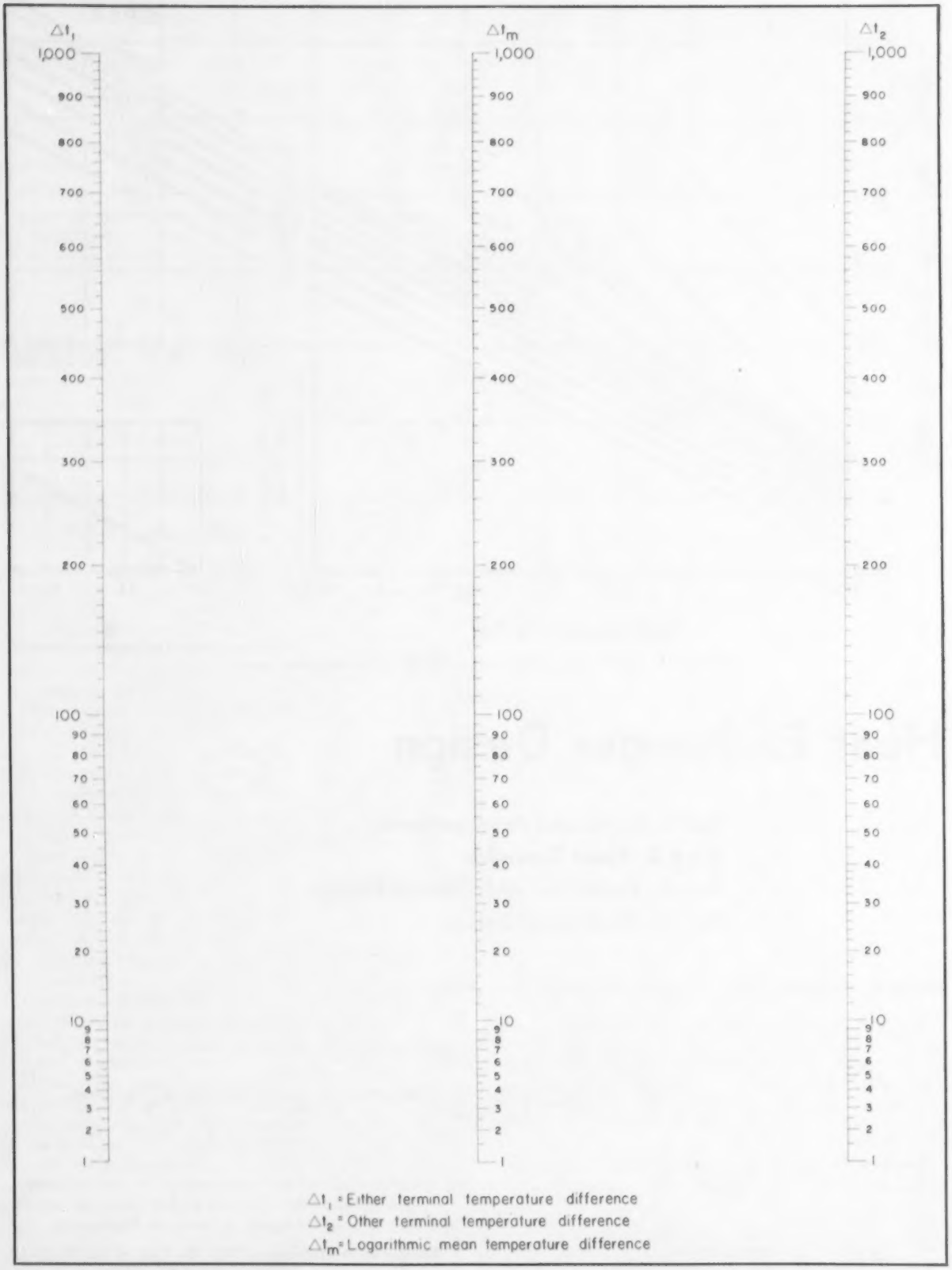
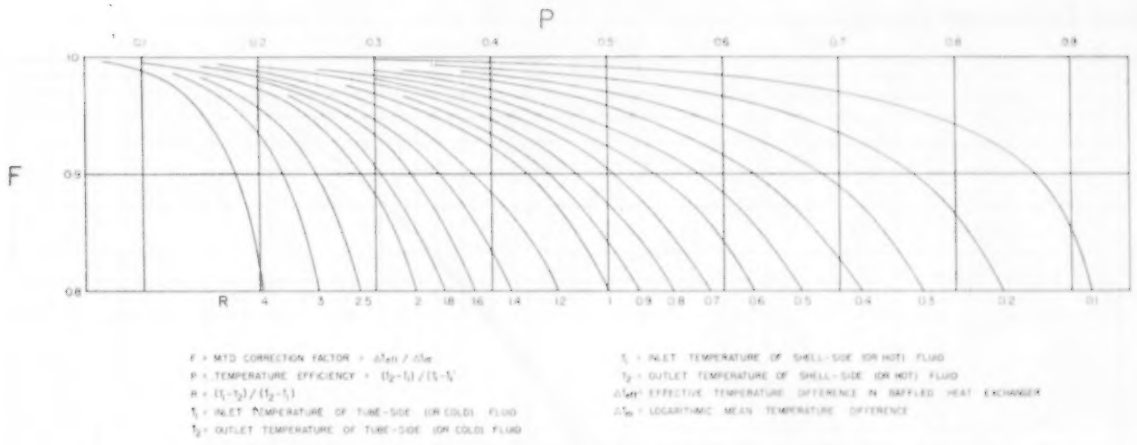


FIGURE 16—Log mean temperature difference (not to be used when one terminal difference exceeds 30 times the other).



F = MTD CORRECTION FACTOR = $\Delta t_{eff} / \Delta t_m$
P = TEMPERATURE EFFICIENCY = $(t_2-t_1)/(T_1-t_1)$
R = $(T_1-T_2)/(t_2-t_1)$
t_1 = INLET TEMPERATURE OF TUBE-SIDE (OR COLD) FLUID
t_2 = OUTLET TEMPERATURE OF TUBE-SIDE (OR COLD) FLUID
T_1 = INLET TEMPERATURE OF SHELL-SIDE (OR HOT) FLUID
T_2 = OUTLET TEMPERATURE OF SHELL-SIDE (OR HOT) FLUID
Δt_{eff} = EFFECTIVE TEMPERATURE DIFFERENCE IN BAFFLED HEAT EXCHANGER
Δt_m = LOGARITHMIC MEAN TEMPERATURE DIFFERENCE

FIGURE 17—MTD correction factor (1 pass shell, 2 or more even numbered tube passes).

ture differential is the logarithmic mean temperature difference.

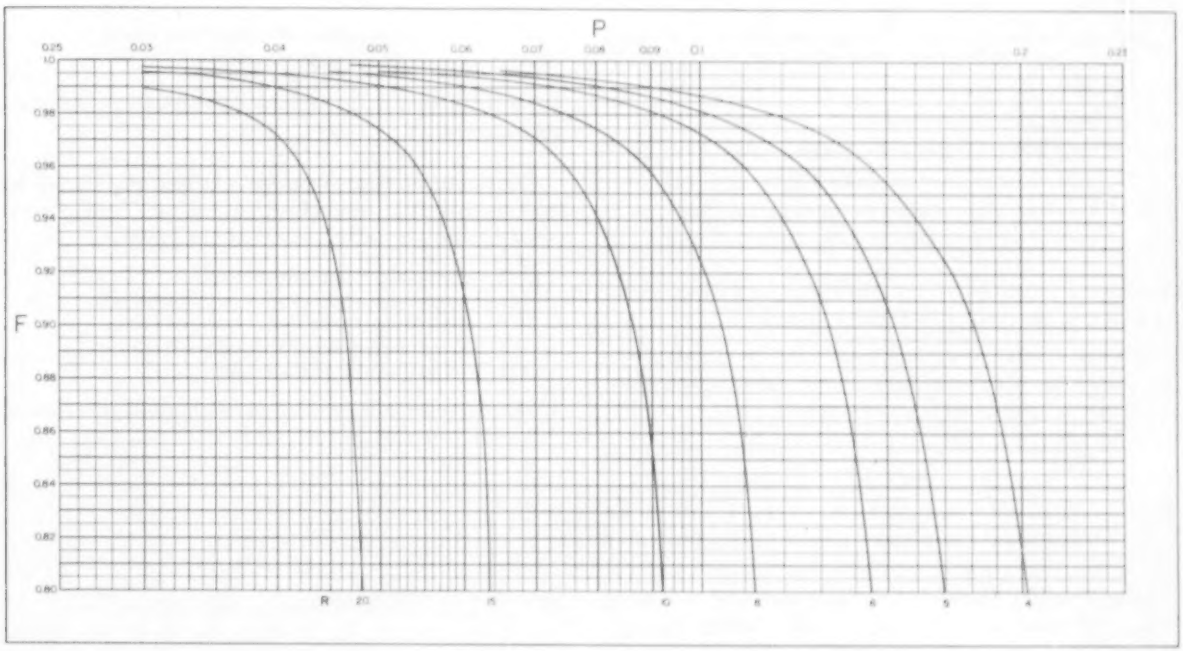
$$\Delta t_m = \frac{\Delta t_1 - \Delta t_2}{\log_e \frac{\Delta t_1}{\Delta t_2}} \qquad (15)$$

where Δt_1 = temperature difference of fluids at one end of exchanger (larger value)
Δt_2 = temperature difference of fluids at other end of exchanger (smaller value)
Δt_m = logarithmic mean temperature difference

An alignment chart for solution of Equation (15), which has been described by Underwood,[2] is shown in Figure 16. To use simply connect the appropriate values on the outer scales by means of a straightedge and read Δt_m on the middle scale.

In baffled heat exchangers, such as shown in Figure 2, flow is not true counterflow since the shell-side fluid continually passes back and forth across the tube bundle. The temperature relations for this type of flow have been formulated.[3, 4] For the case of a single-pass shell and multipass tubes the relation is

$$F_{1,2} = \frac{\frac{\sqrt{R^2+1}}{R-1}\log_{10}\frac{1-P}{1-PR}}{\log_{10}\frac{(2/P)-1-R+\sqrt{R^2+1}}{(2/P)-1-R-\sqrt{R^2+1}}} \qquad (16)$$



F = MTD CORRECTION FACTOR = $\Delta t_{eff} / \Delta t_m$
P = TEMPERATURE EFFICIENCY = $(t_2-t_1)/(T_1-t_1)$
R = $(T_1-T_2)/(t_2-t_1)$
t_1 = INLET TEMPERATURE OF TUBE-SIDE (OR COLD) FLUID
t_2 = OUTLET TEMPERATURE OF TUBE-SIDE (OR COLD) FLUID
T_1 = INLET TEMPERATURE OF SHELL-SIDE (OR HOT) FLUID
T_2 = OUTLET TEMPERATURE OF SHELL-SIDE (OR HOT) FLUID
Δt_{eff} = EFFECTIVE TEMPERATURE DIFFERENCE IN BAFFLED HEAT EXCHANGER
Δt_m = LOGARITHMIC MEAN TEMPERATURE DIFFERENCE

FIGURE 18—MTD correction factor (1 pass shell, 2 or more even numbered tube passes).

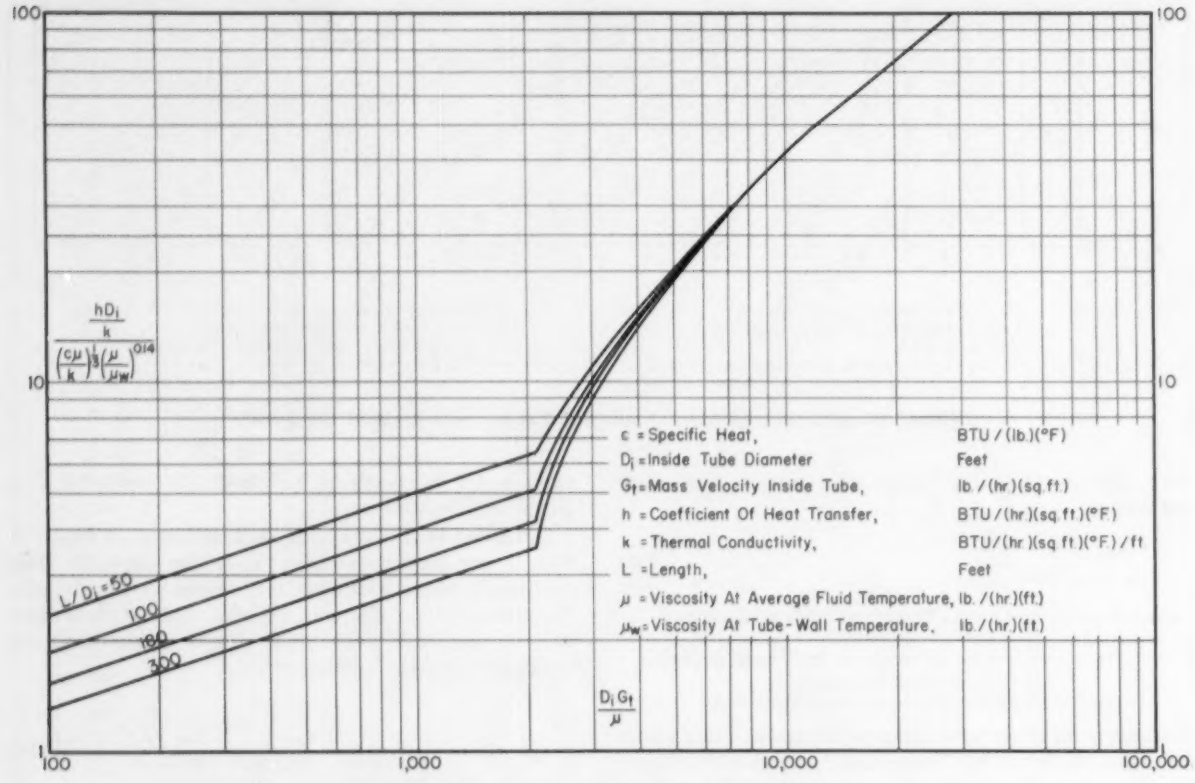


FIGURE 19—Coefficient of heat transfer, fluids inside tubes.

where F = factor by which Δt_m must be multiplied to obtain effective temperature difference

$P = (t_2 - t_1)/(T_1 - t_1)$

$R = (T_1 - T_2)/(t_2 - t_1)$

t_1 = inlet temperature of tube-side (or cold) fluid

t_2 = outlet temperature of tube-side (or cold) fluid

T_1 = inlet temperature of shell-side (or hot) fluid

T_2 = outlet temperature of shell-side (or hot) fluid

Values of F which have been calculated for various values of P and R are plotted in Figures 17 and 18.

For the case of two shell passes and multipass tubes the factor by which the logarithmic mean temperature difference is multiplied is expressed as

$$F_{2,4} = \frac{\frac{\sqrt{R^2+1}}{2\,(R-1)} \log_{10} \frac{1-P}{1-PR}}{\log_{10} \frac{(2/P) - 1 - R + (2/P)\sqrt{(1-P)(1-PR)} + \sqrt{R^2+1}}{(2/P) - 1 - R + (2/P)\sqrt{(1-P)(1-PR)} - \sqrt{R^2+1}}} \quad (17)$$

Heat-Transfer Surface—In a shell-and-tube exchanger this is the total surface of all the tubes which separate the two fluids. By convention this surface is taken at the outside of the tube. For example, a 1-inch tube of any gage has a peripheral length of πD inches = 3.1416 inches. In a one foot length the surface is 37.8 square inches = 0.2618 square feet. For the exchanger

A = total number of tubes × tube length,

$$\text{ft.} \times \frac{\text{sq. ft. of surface}}{\text{ft. of length}} \quad (18)$$

Table 5 lists dimensions of tube sizes which are commonly encountered.

Coefficient of Heat Transfer—As heat flows from hot fluid to cold fluid through the metal tube wall it is opposed by five resistances which are as follows:

(1) r_o = resistance of fluid outside tube
(2) r_{do} = resistance of dirt or scale on outside of tube
(3) r_m = resistance of tube wall
(4) r_{di} = resistance of dirt or scale on inside of tube
(5) r_i = resistance of fluid inside tube

These five resistances are added to obtain R, the over-all resistance to heat transfer.

$$R = r_o + r_{do} + r_m\,(D/D_m) + r_{di}\,(D/D_i) + r_i\,(D/D_i) \quad (19)$$

where D = outside diameter of tube

D_i = inside diameter of tube

D_m = logarithmic mean diameter of tube = $\frac{D - D_i}{\log_e (D/D_i)}$ (20)

FIGURE 20—Reynolds number (inside circular cross section).

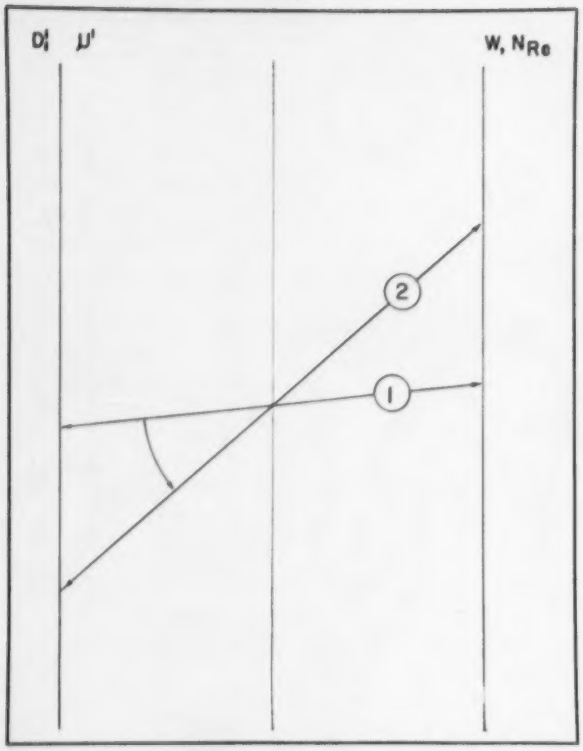
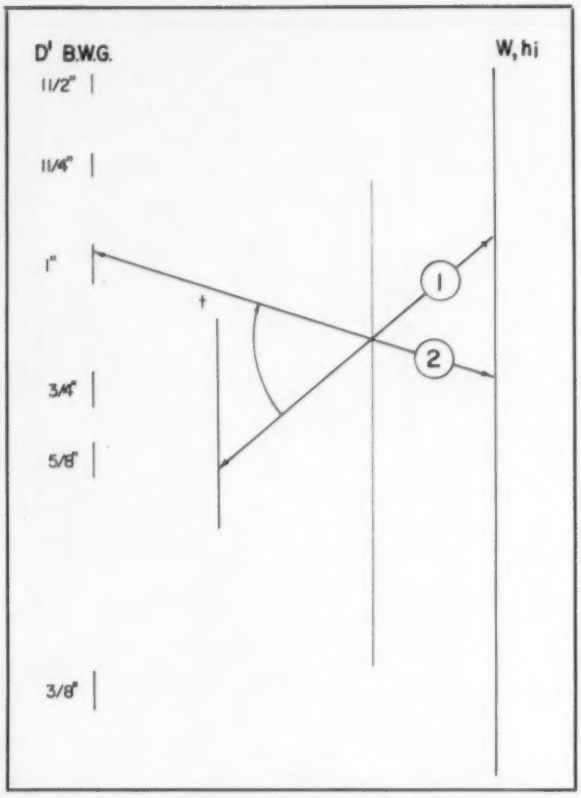


FIGURE 20-A

DIRECTIONS FOR USE: Line 1: Connect the appropriate values on the w and μ' scales with a straightedge. Line 2: Pivot straightedge about the point where Line 1 intersects the uncalibrated line until it connects with the appropriate value on the D_i' scale. Result is read where this new line, shown as Line 2, intersects the N_{Re} scale.

EXAMPLE: Determine the Reynolds number for 1,500 lb./hr. of an oil, whose viscosity is 1.2 centipoises, flowing inside a ¾" O.D., 16 BWG tube ($D_i' = 0.62$"). 1—Connect $w = 1{,}500$ and $\mu' = 1.2$ with Line 1. 2—Pivot Line 1 about its intercept on uncalibrated line until it intersects $D_i' = 0.62$. 3—Read $N_{Re} = 12{,}700$.



(See next page for Figure 21.)

FIGURE 21-A

DIRECTIONS FOR USE: Line 1: Connect values on w and t scales with a straightedge. Line 2: Pivot straightedge about point of intersection of Line 1 with the uncalibrated line and connect with tube-size scale. Result is read where Line 2 intersects the h_i scale.

EXAMPLE: Determine the coefficient of heat transfer referred to the external tube surface when 2,000 lb./hr. of water at 80° F. flow inside a 1" O.D., 16 BWG tube. 1—Connect $w = 2{,}000$ and $t = 80°$ F. with Line 1. 2—Pivot Line 1 about its intercept on uncalibrated line until it intersects 1" O.D. 16 BWG. 3—Read $h_i = 497$.

Of the five component resistance r_m is not of much significance when 1/R is less than 125 which is the usual case with oil refinery exchangers. Values of r_{do} and r_{di}, which allow for the amount of fouling expected outside and inside the tube within a reasonable cleaning period, cannot be predicted with any degree of certainty because of the diverse nature of fouling deposits. These are best obtained from experience with other units in similar type of duty. Values of r_o and r_i depend upon the physical properties of the fluid and its velocity. Since pressure drop and velocity are interrelated it is customary to start with the allowable pressure drop as a base and determine the maximum fluid velocity permissible without exceeding this pressure drop. The higher the fluid velocity the lower the value of r_o or r_i.

Often the term "coefficient of heat transfer" is used instead of "resistance." One is merely the reciprocal of the other.

$$U = 1/R \tag{21}$$

$$\frac{1}{U} = \frac{1}{h_o} + \frac{1}{h_{do}} + \frac{1}{h_m}\left(\frac{D}{D_m}\right) + \frac{1}{h_{do}}\left(\frac{D}{D_i}\right) + \frac{1}{h_i}\left(\frac{D}{D_i}\right) \tag{19a}$$

U = over-all coefficient of heat transfer
h_o = coefficient of heat transfer of fluid outside tube
h_{do} = coefficient of heat transfer of fouling outside tube
h_m = coefficient of heat transfer of tube wall
h_{di} = coefficient of heat transfer of fouling inside tube
h_i = coefficient of heat transfer of fluid inside tube

Tube Wall Resistance—

$$r_m\left(\frac{D}{D_m}\right) = \frac{t}{k}\left(\frac{D}{D_m}\right) \tag{22}$$

k = thermal conductivity, Btu/(hr.) (sq. ft.) (°F.)/ft.
t = thickness of tube wall, feet.

TABLE 5—Tube Dimensions

Outside Diam., Inches	Birmingham Wire Gage	Wall Thickness, Inches	Inside Diam., Inches	O.D./I.D.	External Surface per Foot Length Sq. Ft./Ft.	Internal Cross-Sectional Area, Square Inches	Velocity Conversion Factor, F.
¾	16	0.065	0.620	1.21	0.1963	0.302	471
	14	0.083	0.584	1.284	0.1963	0.268	418
1	14	0.083	0.834	1.199	0.2618	0.546	852
	12	0.109	0.782	1.2787	0.2618	0.480	749
	10	0.134	0.732	1.366	0.2618	0.421	657
1¼	14	0.083	1.084	1.153	0.3272	0.923	1440
	12	0.109	1.032	1.2112	0.3272	0.836	1304
	10	0.134	0.982	1.2729	0.3272	0.757	1181
1½	12	0.109	1.282	1.170	0.3927	1.291	2014
	10	0.134	1.232	1.2175	0.3927	1.192	1860

$$V = \frac{w}{F \times \text{sp. gr.}}$$

Where: sp. gr. = specific gravity referred to water at 60° F.
V = Velocity, Ft./Sec.
w = Rate of Flow, Lb./Hr. per Tube

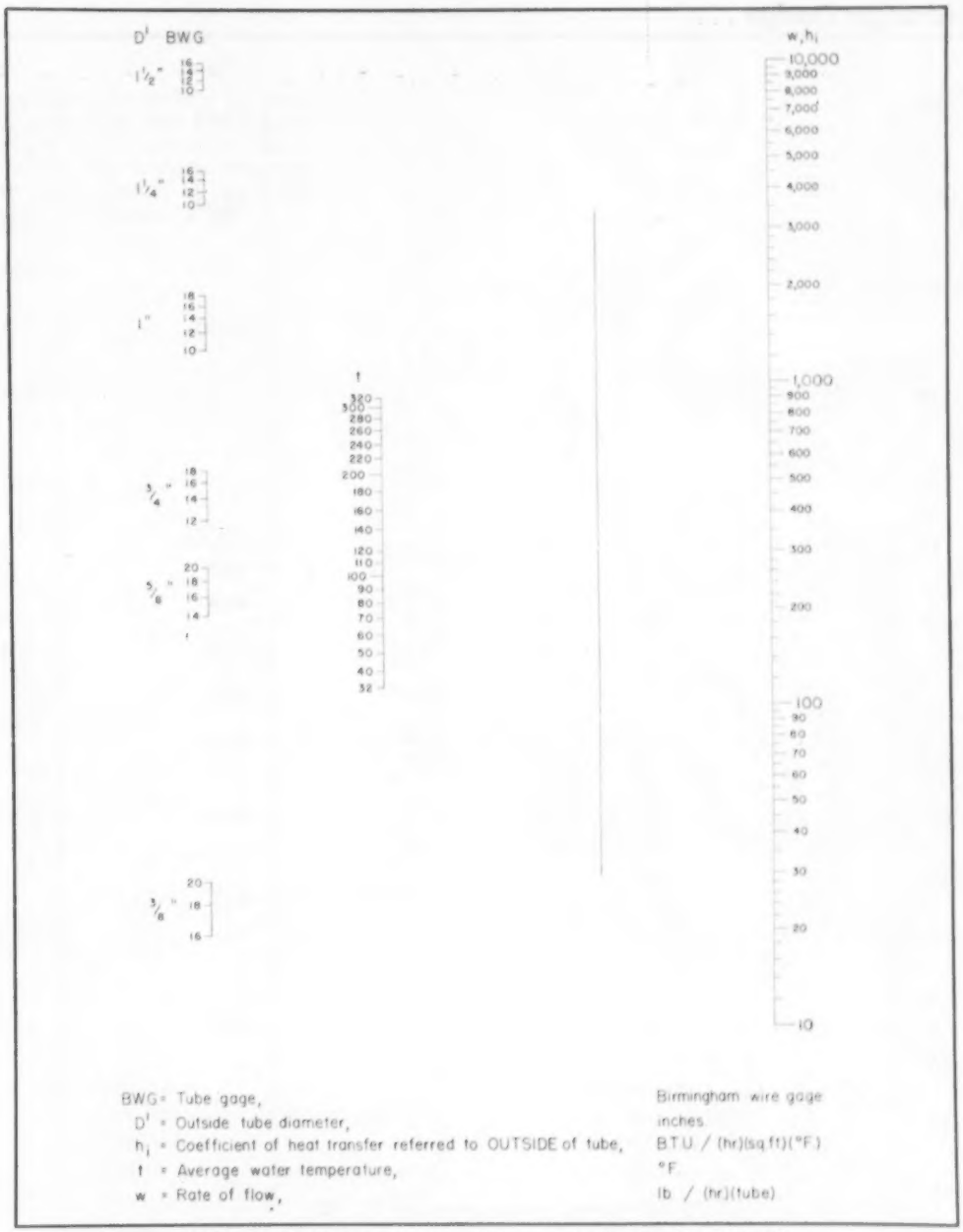


FIGURE 21—Coefficient of heat transfer, water inside tubes ($N_{Re} > 2{,}100$).

Fouling Factors—For flowing cooling water a fouling factor of 0.003 is generally used. For clean liquids and clean condensing vapors a fouling factor of 0.001 is used. For liquids the fouling factor may range upward from 0.001 depending on the service. Values of r_{di} must be referred to the external tube surface by multiplying by (D/D_i).

Coefficient of Heat Transfer for Flow Inside Tubes—The Sieder and Tate[5] relation involving coefficient of heat transfer, mass velocity, physical properties of a fluid and inside tube diameter is shown in Figure 19 in terms of dimensionless groups with Reynolds number as abscissa. It will be seen from Figure 19 that there are three distinct zones of flow. The first is the streamline region for values of Reynolds number of 2100 and less. The series of parallel lines is expressed by the equation

$$\frac{hD_i}{k} = 1.86\left[\left(\frac{D_iG_t}{\mu}\right)\left(\frac{c\mu}{k}\right)\left(\frac{D_i}{L}\right)\right]^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14} \quad (23)$$

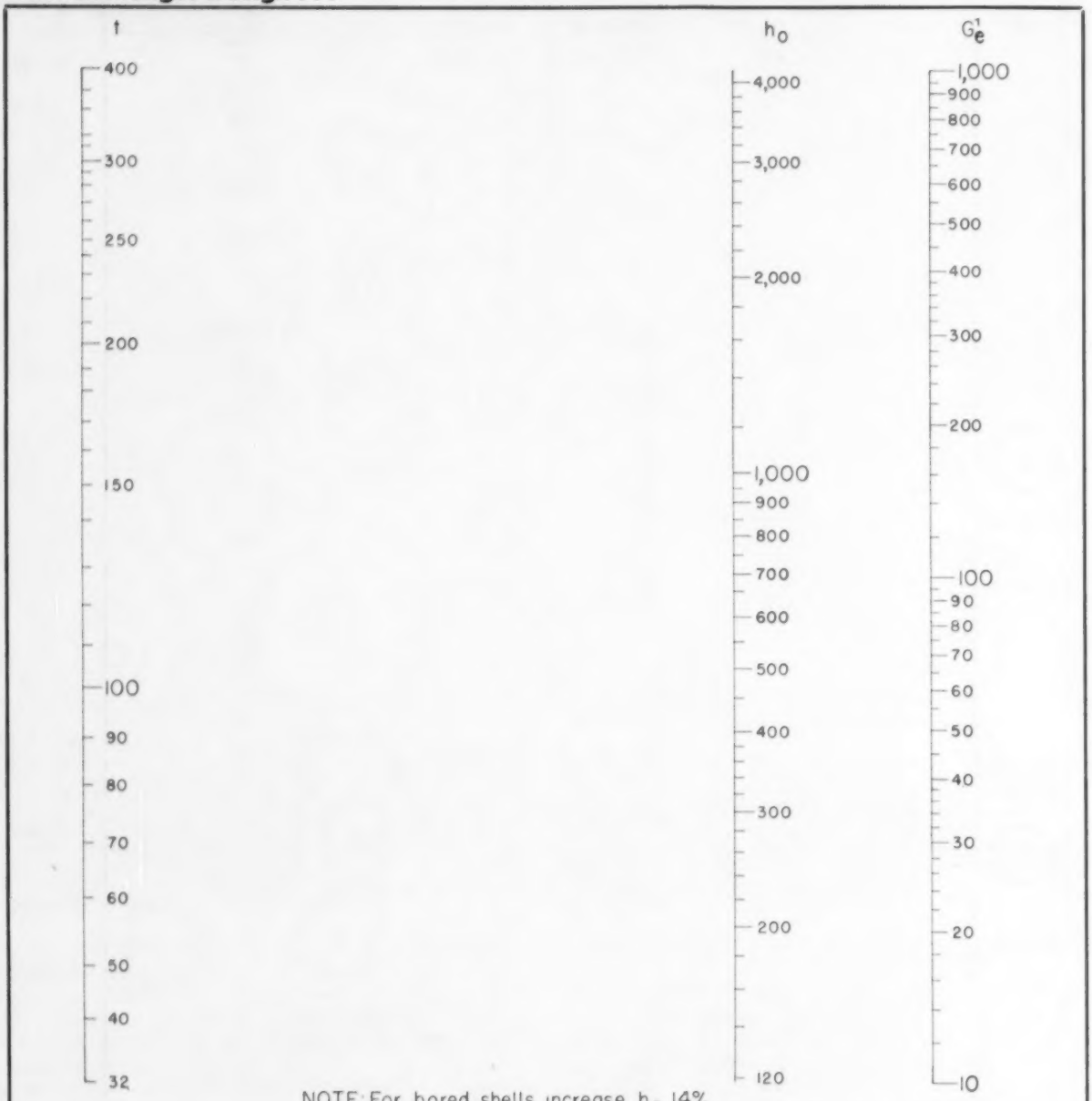
For those cases where the Grashof number exceeds 25,000 the value of h obtained from Equation (23) must be corrected for the increase in heat transfer due to natural convection effects by multiplying by the term

$$0.8\,(1 + 0.015\,N_{Gr}^{1/3})$$

in which the Grashof number is

$$N_{Gr} = \frac{(\beta\Delta t)\,(D_i^3\rho^2 g)}{\mu^2} \quad (24)$$

At values of Reynolds number of 10,000 and over



NOTE: For bored shells increase h_o 14%

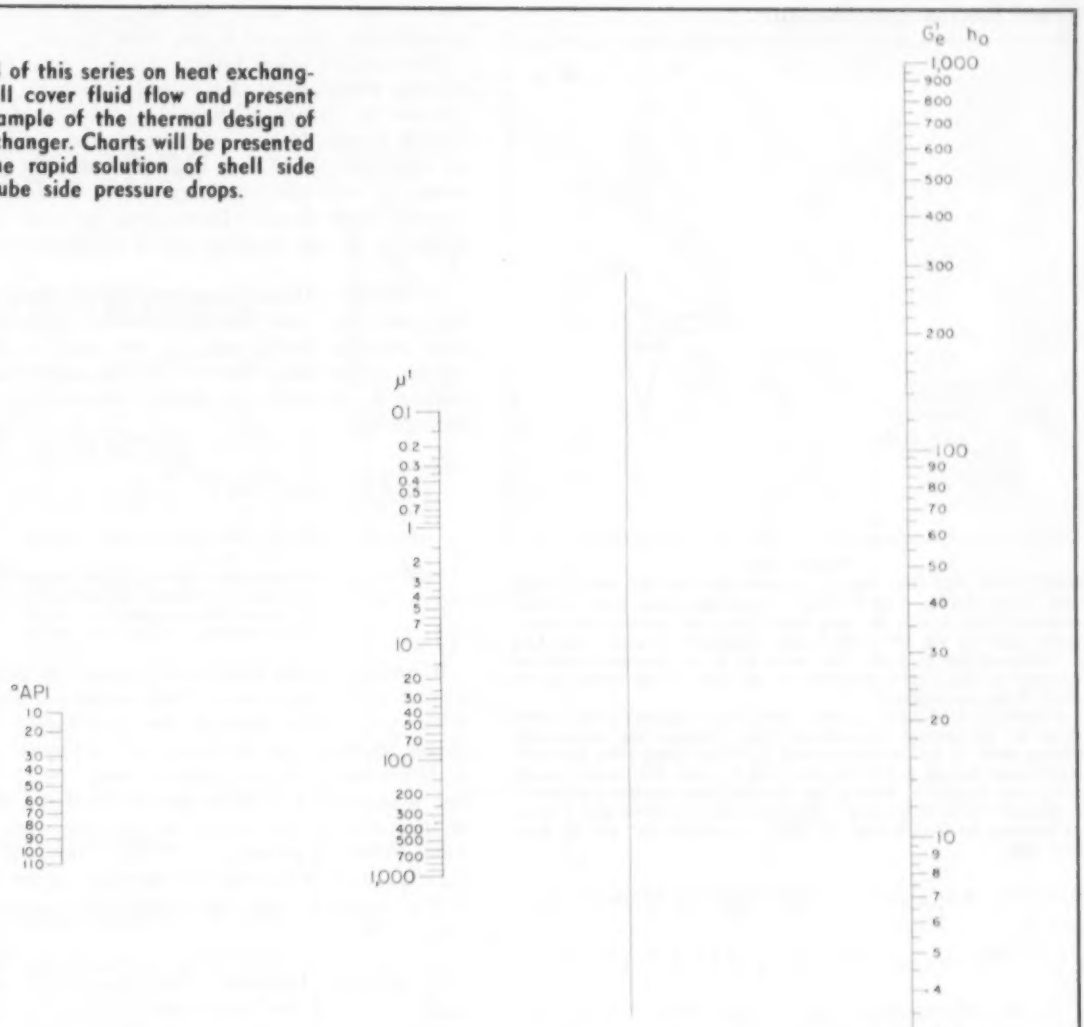
Chart based on ¾" D' tubes.
For other sizes multiply chart reading by:

D'	⅝"	¾"	1"	ANY
MULTIPLIER	1.076	1.0	0.89	$(0.75/D')^{0.4}$

G'_b = Mass velocity through baffle opening, lb/(sec.)(sq.ft.).
G'_c = Crossflow mass velocity, lb/(sec.)(sq.ft.).
$G'_e = (G'_c G'_b)^{1/2}$, geometric mean mass velocity, lb/(sec.)(sq.ft.).
h_o = Shell-side heat transfer coefficient, B.T.U. / (hr)(sq.ft.)(°F.).
D' = Outside tube diameter, Inches.
t = Average water temperature, °F.

FIGURE 22—Shell-side coefficient of heat transfer for water in exchangers having segmental baffles.

Part 3 of this series on heat exchangers will cover fluid flow and present an example of the thermal design of an exchanger. Charts will be presented for the rapid solution of shell side and tube side pressure drops.



°API = Gravity, degrees API

G'_b = Mass velocity through baffle opening, lb / (sec)(sq ft).

G'_c = Crossflow mass velocity, lb / (sec)(sq ft)

$G'_e = (G'_c G'_b)^{1/2}$, geometric mean mass velocity, lb / (sec)(sq ft).

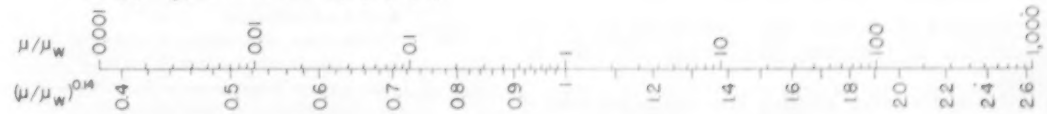
h_o = Shell-side heat transfer coefficient, BTU / (hr)(sq ft)(°F)

μ' = Viscosity at average temperature, centipoises.

μ'_w = Viscosity at tube-wall temperature, centipoises

NOTES

1. Multiply h_o, obtained above, by $(\mu/\mu_w)^{0.14}$



2. Chart based on ¾" O.D. tubes, for other sizes divide chart reading by

O.D.	⅝"	¾"	1"	ANY
DIVISOR	0.93	1	1.12	$(O.D.)^{0.4}$

3. For bored shells increase h_o 14%

FIGURE 23—Shell side coefficient of heat transfer for petroleum oils.

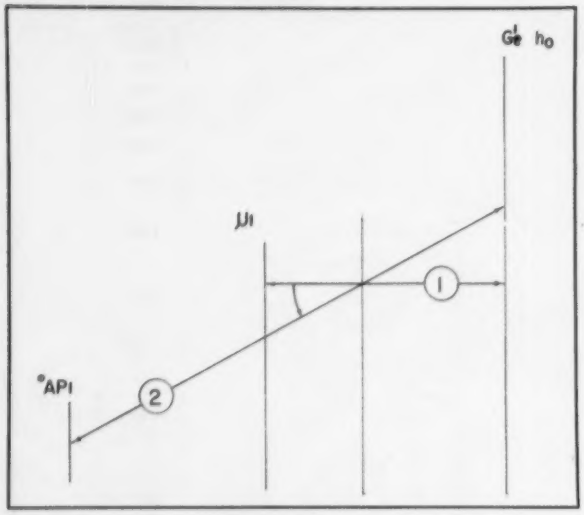


FIGURE 23-A

DIRECTIONS FOR USE: Line 1: Connect values on G_e' and μ' scales with a straightedge. Line 2: Pivot straightedge about point of intersection of Line 1 with the uncalibrated line and connect with appropriate value on the API scale. Result is read at the point where Line 2 intersects the h_o scale. The value of h_o so obtained should be adjusted by the factors described in the notes at the bottom of the chart, if they are applicable.

EXAMPLE: A 52° API gasoline which has a viscosity of 0.5 centipoise at its average temperature flows through the segmentally baffled shell of an exchanger with ¾" O.D. tubes. The geometric mean mass velocity is 77.8 lb./(sec.)(sq. ft.) and the viscosity gradient is very close to 1. What is the shell-side heat transfer coefficient? 1—Connect $G_e' = 77.8$ and $\mu' = 0.5$ with Line 1. 2—Pivot Line 1 about its intercept on uncalibrated line until it intersects 52° API. 3—Read $h_o = 184$.

turbulent flow occurs and the equation of the straight line is

$$\frac{hD_i}{k} = 0.027 \left(\frac{D_i G_t}{\mu}\right)^{0.8} \left(\frac{c\mu}{k}\right)^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \qquad (25)$$

In the intermediate region where Reynolds number varies from 2100 to 10,000 the relation does not follow a straight line.

c = specific heat, Btu/(lb.)(°F.)
D_i = inside tube diameter, feet
g = acceleration of gravity, 4.17×10^8 ft./(hr.)(hr.)
G_t = mass velocity inside tube, lb./(hr.)(sq. ft.)
h = coefficient of heat transfer, Btu/(hr.)(sq. ft.)(°F.)
k = thermal conductivity, Btu/(hr.)(sq. ft.)(°F.)/ft.
L = length, feet
N_{Gr} = Grashof number
β = thermal coefficient of cubical expansion, 1/°F.
Δt = temperature difference, °F.
ρ = density, lb./cu. ft.
μ = viscosity at average fluid temperature, lb./(hr.)(ft.)
μ_w = viscosity at tube-wall temperature, lb./(hr.)(ft.)

An alignment chart has been constructed to permit rapid solution of Equation (25) which will now be described.

In order to determine whether flow inside the tube is in the streamline, turbulent or intermediate region it is necessary to evaluate the Reynolds number. This is done by use of Figure 20 which is based on the equation

$$N_{Re} = 6.31 \frac{w}{\mu' D_i'} \qquad (26)$$

where D_i' = inside tube diameter, inches
N_{Re} = Reynolds number
w = rate of flow, lb./(hr.)(tube)
μ' = viscosity at average fluid temperature, centipoises

Instructions for using this chart and solution of an example are given in Figure 20A.

The case of water flowing inside a tube is most frequently encountered. For water Equation (25) is applicable to values of Reynolds number of 2100 and higher. Figure 21 is an alignment chart for the solution of Equation (25) after multiplication by (D_i/D_o) in order to refer the coefficient of heat transfer to the external tube surface. Instructions for and an example of the use of this chart are given in Figure 21A.

Coefficient of Heat Transfer for Flow Outside Tubes—For industrial heat exchangers using segmental baffles with unbored shells, such as are used in oil refinery service, it has been shown[6] that the coefficient of heat transfer for the shell-side fluid is expressed in the following equation

$$\frac{hD}{k} = 0.22 \left(\frac{DG_e}{\mu}\right)^{0.6} \left(\frac{c\mu}{k}\right)^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \qquad (27)$$

where G_e, which is a weighted mass velocity, $= (G_c G_b)^{1/2}$ lb./(hr.)(sq. ft.)
and G_c = crossflow mass velocity, lb./(hr.)(sq. ft.)
G_b = mass velocity through baffle opening, based upon the area of the opening less the area of the tubes passing through it, lb./(hr.)(sq. ft.)

Alignment charts have been prepared to permit rapid solution of this equation for fluids commonly encountered. When water flows through the shell Figure 22 is employed to obtain the coefficient of heat transfer. To use, simply connect the appropriate values on the two outside scales with a straightedge and read the value of h_o at the point of intersection of this line with the inner scale. When a petroleum oil flows through the shell Figure 23 is used to ascertain the value of the coefficient of heat transfer. The use of this chart is illustrated in Figure 23A.

Temperature Gradient—The temperature drop from hot fluid to cold fluid is proportional to the resistance to heat flow.

$$\Delta t_r = \frac{r}{R} (t_h - t_c) \qquad (28)$$

The temperature at the inner tube wall is expressed by the relation

$$t_w = \left(\frac{r_{di} + r_i}{R}\right) \Delta t + t_t \qquad (29)$$

where r = any component resistance
r_{di} = resistance of dirt or scale on inside of tube
r_i = resistance of fluid inside tube
R = total resistance
t_c = average temperature of cold fluid
t_h = average temperature of hot fluid
t_t = average temperature of fluid inside tube
t_w = temperature at inner tube wall
Δt = effective temperature difference in unit
Δt_r = temperature drop across r

NOTE

References to the Literature are shown in "Literature Cited" which appears at the end of Part I, in the July, 1955, issue of PETROLEUM REFINER.

End of Part II. Part III will appear in an early issue.

Figure 2 used on page 95 of Part I of the Donohue article was used through courtesy of Industrial and Engineering Chemistry. Such credit was inadvertently omitted in the August issue.

The Hoechst Continuous Coking Process

- **Indirect heating eliminates side reactions.**
- **Contamination of the cracked products is avoided.**
- **Higher yield of unsaturated hydrocarbons.**

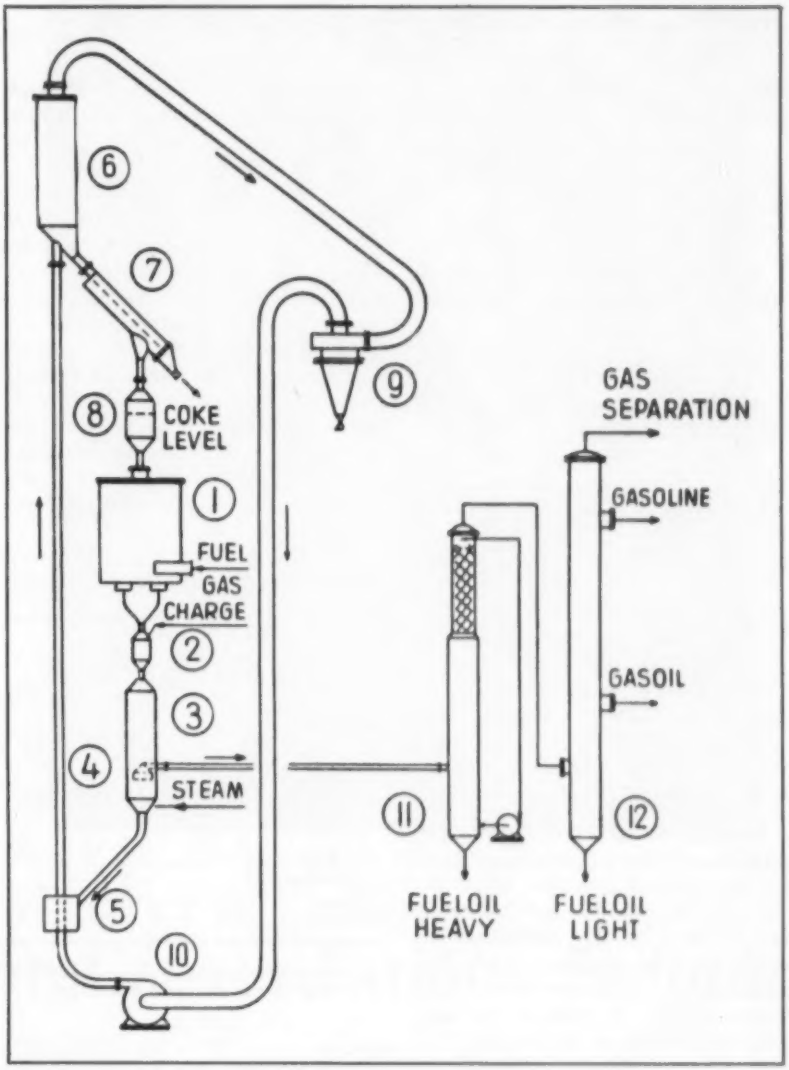


FIGURE 1—Flow diagram of the Hoechst Coking process.

H. Krekeler,
Farbwerke Hoechst A.G. Frankfurt a. Main-Hoechst

THE FORMATION of olefins depends on the attainment of a sufficient temperature level. Therefore an economic yield of olefins is only possible by going to really high cracking temperatures. It was, therefore, necessary to develop a process which would produce olefins as the main product.

The Continuous Coking process developed by Farbwerke Hoechst AG, is based on this concept. As feed material it is possible to use crude oil, brown coal tar oils, light or heavy distillates, cracked oils, and residues from topping and vacuum distillation including those with the highest Conradson carbon test. The main features of this coking process are:

1. The process is of the fluid type.

2. At the first start up the pebbles consist of coke pellets which have been subjected to a high temperature; the pebbles subsequently required are

made during the operation of the process.

3. The heating of the pebbles is indirect, in tube bundles; the return of pebbles to the top of the apparatus is effected by a hot gas lift.

4. The lift gas can, for example, be nitrogen, hydrogen or some of the lower hydrocarbons.

5. The lift gas is circulated.

6. All the main parts of the apparatus are of metal.

The indirect heating of the coke pebbles eliminates side-reactions which could occur in the direct heating of the coke at the temperatures of about 700 C used in the process. Furthermore, contamination of the cracked products by flue gas is entirely avoided. By using gaseous hydrocarbons, such as ethane returned from the gas separation plant, as lift gas, it is possible to obtain a somewhat higher yield of unsaturated hydrocarbons. The attrition of the coke is so low that it can be neglected.

Description of Pilot Plant—The pilot plant (Figure 1) was constructed for an input of five tons of oil per day. Coke pebbles are indirectly heated in a tubular preheater (1) made of heat resisting steel. The maximum temperature of these heated pebbles depends on the temperature desired in the reactor. The feed is preheated and injected into the mixing zone (2). The main reaction takes place immediately. The coke formed deposits in thin layers on the coke pebbles. The "maturing" of the coke takes place in the reactor (3). The hot gases and vapors comprising the reaction products leave at the bottom of the reactor and are rapidly cooled in the quench tower (11) by heavy cracked oil fractions and finally separated in a fractionator (12).

The gases pass overhead from the column into the gas separating plant. The heavy fuel oil obtained is discharged from the bottom of the quench tower. The coke pebbles, before leaving the reactor through the mushroom-shaped separator (4), are stripped by steam in order to prevent the pebbles from adhering to one another and to avoid further gasification in the coke heater. The coke passes into the lift vessel (5) through an adequate sealing zone and is then elevated through the lift pipe by means of the lift gas.

The coke separator (6) which disengages lift gas from the coke, is at the top of the unit. The coke falls by gravity through a sifting device (7) into an intermediate vessel (8), in which the coke is kept at a uniform level by removing the excess during the sifting process. The coke cycle is completed by returning the coke from the intermediate vessel to the preheater. The lift gas leaving the coke separator still contains minute amounts of coke dust which are removed by a cyclone system (9).

The lift gas cleaned in this way flows to the hot gas blower (10) and is there boosted to the required pressure for lifting the pellets. This completes the lift gas cycle.

This versatility of the process is not restricted to the feed material but applies in an even higher degree to the reaction conditions. It is, for example, possible to conduct the cracking process so as to obtain a maximum yield of liquid oil fractions by operating at a suitable reaction temperature.

By feeding vacuum residues, a yield of 60-65 percent by weight of oily fractions, suitable as feed material for a further cracking process, can be obtained. If a high yield of gas with a high percentage of olefins is required, this can be attained by suitably altering the temperature of the reactor.

Coke: The coke pellets charged at the first start-up have a diameter of 5-10 mm and are pelleted from petroleum coke; they are characterized by high resistance to attrition. During the reaction they take up a new layer of coke at every passage through the mixing zone. After a considerable stay in the apparatus, the newly formed shell becomes heavier than the original core.

The largest pebbles are continuously discharged and the shell can easily be broken away from the core by suitable mechanical means, since this layer is mechanically less strong than the core. By the breakage of coke shells in the coke cycle itself, smaller lumps are formed which become rounded by abrasion and constitute the seed material on which new pellets will form. The distribution of the different pebble sizes tends towards an equilibrium. The coke produced is obtained in the form of broken coke shells. Even if broken pieces from the breakdown of some of the original pellets become mixed with the broken pieces of shell, the quality of the coke product is not spoiled since the composition of the two is nearly the same.

The properties of the coke produced depend on the composition of the feed material. A typical coke analysis, Table 4, shows approximately the values when a suitable feed material is employed.

TABLE 1. Feed Oils

		Hohner Crude Oil	Tar Oil (Brown Coal)	Topping Residues	Vacuum Residues
Specific Gravity:					
20° C		0.855	0.996	0.94	0.98
Conradson Carbon	%	3.8	2.25	6	19.5
Asphalt Content	%	1.31	....	2.27	61
Ultimate Analysis:					
Carbon	%	85.70	82.64	86.02	86.61
Hydrogen	%	13.0	10.34	11.54	10.57
Oxygen	%	0.43	4.68	1.16	....
Water	%	0.31	0.30	0.3	0.44
Sulphur	%	0.54	1.91	1.17	1.63
ASTM Boiling Range:					
170° C	%	16	....	0	0
170-340° C	%	49	25	10	10
Residues	%	35	75	90	90

TABLE 2. Experimental Conditions

FEED OIL	Hohner Crude Oil	Brown Coal Tar Oil	Topping Residues	Vacuum Residues
Rate of Feed, kg/hr.	193.0	80	112	140
Temperature in the Mixing Zone, °C	680	630	580	680
Pressure in reactor, mm Water	400	250	200	400
Coke Circulation, kg/hour	4000	2600	3500	4000

TABLE 3. Experimental Results

	Hohner Crude Oil	Brown Coal Tar Oil	Topping Residues	Vacuum Residues
Gaseous Hydrocarbons H_2-C_4 incl. as Weight Percent Calculated on Feed	55.3	55.0	14.0	40.6%
Of the Above Olefines as Weight Percent Calculated on Gas	58.8	49.0	58.4	48.6%
Liquid Reaction Products as Weight Percent Calculated on Feed	38.2	42.0	75	34.2%
Coke	6.5	3.0	11.0	25.2%

TABLE 4

Analysis of Coke from Hohner Crude Oil

C	H	S	Volatiles Up to 850° C	Ash	(Weight Percent)
95.75	0.95	0.96	0.44	0.16	%

ACKNOWLEDGMENT

This paper was presented before the Fourth World Petroleum Congress and is published through the courtesy of Carlo Colombo, Campo Marzio 74, Rome. The complete text of this paper will be published in the proceedings and may be obtained directly from Mr. Colombo.

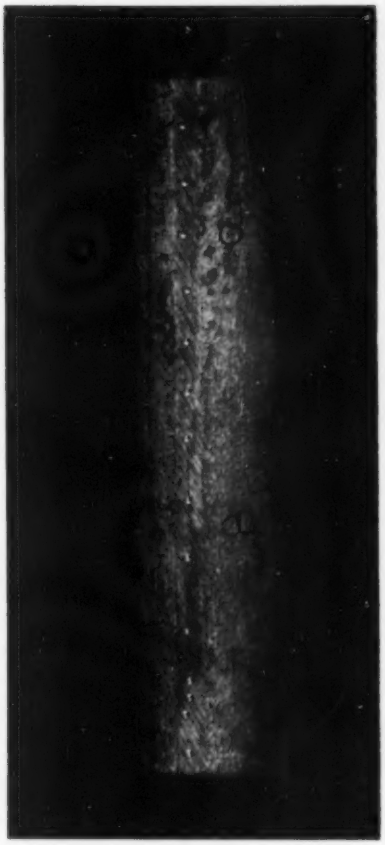


FIGURE 1—A sucker rod that was operating in a corrosive crude. See magnifications of the circled areas in Figure 2.

FIGURE 2—20 magnifications of the circled areas of Figure 1. This situation was discovered with ultrasonic inspection.

How Corrosion Causes Fatigue Failures

Did you know that wet steam produces only a trivial weight loss on 12 percent chromium stainless steel, but will cut its endurance limit in half?

William G. Dudley and John J. McKetta,
Refiner Staff

PASSENGER CAR axles located under the drain of the womens' lavatory in a certain group of cars broke repeatedly and the problem gave one of the major railroads a very serious headache before it was solved.

The same axle always broke in the same location. Weight distribution in the car was balanced. The trucks were identical. Vibration studies gave no clues. Finally somebody noted the strategic location of this particular axle. The drain was moved. The failures stopped.

This incident, related by a faculty member of a famous engineering school some years ago, illustrates what havoc can be wrought by a little corrosion combined with fatigue. There was little noticeable corrosion; but this is typical of corrosion-fatigue. Wet steam produces only a trivial weight loss on 12 percent chromium stainless steel but will cut its endurance limit in half. A notched bar of heat treated SAE 3140 had an endurance limit of 90,000 pounds per square inch in dry air. In a stream of tap water the endurance limit was only 9000 psi. for 10 million cycles. If unexpected fatigue failures occur with good design and the absence of stress raisers, corrosion may well be the cause.

Petroleum production, especially, has been plagued with a combination of corrosion and fatigue. Sucker rods and drill collars are the most frequent victims. The shafts of reciprocating and centrifugal pumps, marine propulsion shafting, springs and even bearings are often subject to corrosion-fatigue. Strictly speaking, the only case of pure fatigue is in dry air. Corrosion may reduce the dry air en-

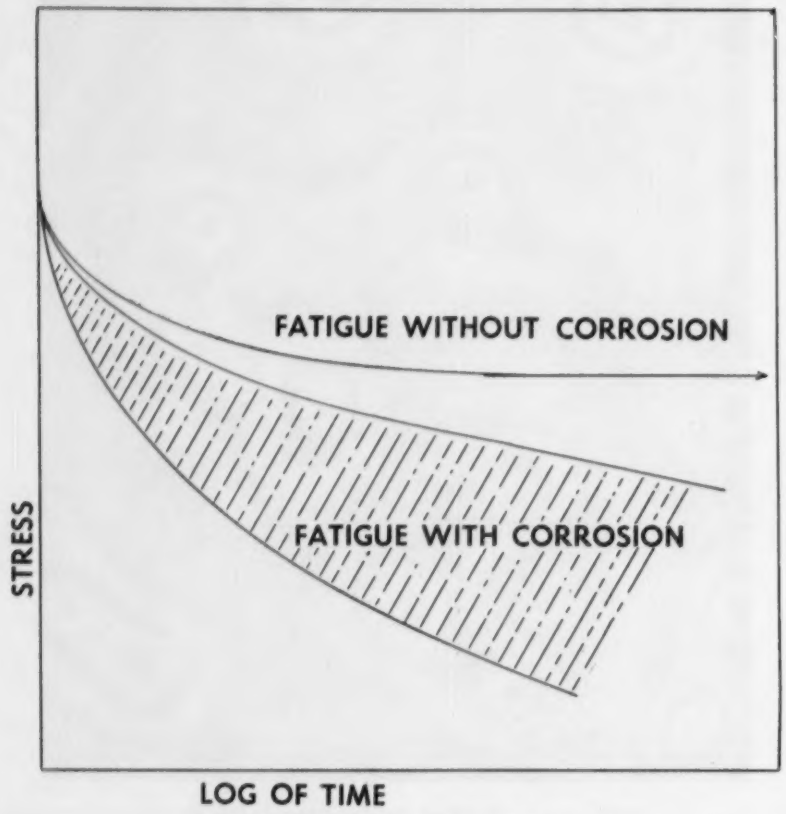


FIGURE 3—Effect of corrosion on fatigue.

durance limit of metals by almost any factor depending on the environment, fatigue cycle and composition of the metal.

It is a great mistake to speak of a metal having a corrosion fatigue limit. The data quoted above should be regarded as highly qualitative and not indicative of fixed limits. Corrosion is usually a continuous process.

The corrosion process, because of its electrolytic nature, is inherently irregular in its attack upon an originally smooth surface. The bottom of the irregularities formed by corrosion are points of stress concentration and, therefore, points of relatively higher corrosion rates. Energy relationships alone would give higher rates, but in the case of dynamic loading, mechanical effects are more significant. They tend to break the film of corrosion product with each repetition of load, thereby exposing fresh metal to attack. Recent experimental work has shown that corrosion rates on unfilmed metal are much higher than has been generally supposed. Furthermore as the depth of attack increases, the electrolytic effects become more pronounced. The bottom of the pit or crack becomes increasingly anodic with respect to the surrounding filmed area which functions as the cathode of the cell.

In an unstressed member, pits are usually round bottomed and relatively shallow. Repetitive rupture of the film at the sides of pits causes very small cracks to form. These propagate and eventually link up. If you are prompt and lucky, an inspection will catch the situation and save the damage and loss which an unexpected failure can cause. Often there may be no tell-tale pits with little side cracks and very little evidence of corrosion. It is best, however, to consider corrosion guilty until proved innocent.

Except for some non-ferrous metals and stainless steels which are inert in certain environments, protection against corrosion fatigue is chiefly a matter of design and intelligent use and maintenance. Pump shafts and sucker rods are over-designed and frequently made of corrosion-resistant material as well. Where pump shafts prove inadequate and the impeller does not permit increasing the shaft diameter, three remedies are open. Several steel companies produce an age hardening stainless steel in which the yield strength may reach levels of 80,000 to 120,000 psi. If stainless steel is not compatible with the environment, it is likely that an age hardening nickle-copper alloy containing aluminum will be. It reaches similar strength levels. The third alternate is to completely shield the shaft from the environment with sleeves, coatings and mastics.

Where condensation may collect on or around moving parts, drainage and ventilation should be provided. Protective coatings may be dangerous unless carefully applied and maintained. A local break in a paint film may provide a point of severe local attack at which a crack will develop. If dissimilar metals are involved, coating the noble metal will reduce galvanic corrosion of the less noble member.

Metallic coatings which are cathodic to the base metal should be avoided in general, although some success has been reported with nickel plated sucker rods. Electroplated zinc, where it is feasible, seems one of the best means of reducing corrosion-fatigue.

Hot dip galvanizing reduces endurance limits because of surface irregularities introduced during the process. These are pickle-pitting, irregular penetration of the zinc, and possibly points injured by minute internal explosions of hydrogen occurring when the freshly pickled steel is immersed in the zinc bath.

Inhibitors of both the polar adsorbing and chromate types are helpful. With the latter, care must be taken to maintain the desired concentration at all times, or it will do more harm than good.

Notches and structural discontinuities should be eliminated to the greatest possible degree.

Cathodic protection is excellent where it can be applied. It has been used with excellent results on drill collars and ship bottoms containing a built-in notch.

If failures occur with good design and freedom from stress raisers, look for a corrosion problem and analyze it. ##

A NEW SERIES

EACH OF you has used a nomograph in your work. Each of you has also wished that you could make your own nomograph for various equations or data. Here's your chance to do just that. We asked Francis Winn to prepare a series of articles on the preparation of nomographs for you and to make them simple.

Starting in this article, Francis Winn takes you through each step in making a nomograph. Later he will show you how to handle the so-called "more-complicated" equations. He will even show you how to make the nomographs directly from experimental data.

A simple procedure for the layout and construction of nomographs is described in this series. Linear coordinate plots are transformed into nomographs and used to explain the basic principles which are involved. The procedure can be applied to the construction of nomographs from equations or from empirical correlations which are available in the form of coordinate plots or tables.

A new method of correlating experimental data in three variables is covered. This procedure, which makes use of the nomographic techniques, is especially useful when applied to data which are random in nature. In some respects this procedure is superior to statistical methods because it requires fewer assumptions concerning the functional form of the relationship. The method is fast and results in good accuracy.

NOMOGRAMS . . . Make Your Own

Part 1. How to prepare various types of scales

Part 2. Laying out the nomogram

Part 3. How to prepare different types of nomograms

Francis W. Winn
Fractionation Research, Inc.
Alhambra, California

NOMOGRAMS or alignment charts are becoming increasingly important for correlation and presentation of experimental data and for solving complex equations. Texts on this subject require considerable study before a nomogram may be constructed for even the simplest of equations. There appears to be no text which gives an adequate treatment to the nomographic correlation of experimental data or to the nomographic presentation of experimental data previously correlated and available in chart or tabular form.

A procedure has been developed which simplifies the problem considerably. This procedure is explained by analogies with the familiar coordinate chart.

The drafting tools essential for the rapid construction of a nomogram are a drawing board, a T-square or parallel edge, a 90° triangle, an assortment of French and ships curves, arithmetic and logarithmic graph paper, drafting tape, and a sharp pencil.

Nomograms and Coordinate Plots

The Essential Requirements of a Graphical Presentation of Data. Both nomograms and coordinate plots are graphical means of representing a mathematical or empirical relationship between two or more variables.

A three-variable coordinate plot shows a relationship by a cross hatch or network of three families of lines; the ordinate and abscissa, i.e., a Car-

tesian coordinate system, and a third family of lines, the parameter. Normally the ordinate and abscissa are families of straight parallel lines at right angles to each other; but, they may assume other patterns, e.g., the octane blending chart. The parameter, however, must have a pattern which is compatible with the ordinate and abscissa in order to satisfy the relationship.

A three-variable nomogram may be defined as a graphical device of three scales. A straight line through any values on two of the scales cuts the third scale at a value which satisfies the relationship. Two of the scales may have a number of different positions; however, the third scale must have a position which is compatible with the first two in order to satisfy the desired relationship. Stated in another way, if any two scales of a nomogram can be drawn on a sheet of paper, there is one and only one position of the remaining scale which will satisfy the desired relationship.

This analogy between coordinate plots and nomograms obviously can be extended to more than three variables. A four-variable nomogram is the equivalent of a series of three-variable coordinate plots.

Can Nomograms and Coordinate Plots be Interchanged? — Yes. Any nomogram can be transformed into an equivalent coordinate plot which will consist entirely of families of straight lines, no one of which is necessarily a parallel family. Likewise any coordinate plot of families of straight lines can be transformed into an equivalent nomogram. However, a coordinate plot having a family of curved lines can be represented by a nomogram only if it can be rectified, i.e., made to be linear. Rectification of a family of curves by a rearrangement of the ordinate and/or abscissa of a coordinate plot is an absolute prerequisite to the construction of a nomogram. Some families of curves cannot be rectified, and therefore, no nomogram can be constructed for them. Also, it is impossible to present some equations in nomographic form.

Choice Between a Nomogram and a Coordinate Plot—The choice between a nomogram or a coordinate plot as a means for presentation of data or an equation depends on the relative cost of construction and relative utility in one form or the other. If only three variables are involved and the number of values of the parameter required for ease of interpolation is small, a coordinate plot frequently is more desirable than a nomogram because its construction usually entails less time and expense. When the required number of values of the parameter is large for a three variable relation, or for relations of four or more variables, a nomogram may have the advantage.

Are Nomograms Accurate?—If a linear coordinate plot can be constructed to show a relationship accurately, a nomogram can also be constructed which will show the same relationship and have the same accuracy. There are relationships which cannot be rectified: therefore, attempts to place them in nomographic form will result in inaccuracies. However, many relationships involving physical or chemical properties of compounds and mixtures can be placed into nomographic form.

Interpolation on a nomogram is accomplished by the visual subdivision of the distance between two points along scales. On a coordinate plot it is the visual subdivision of the distances between lines of families of curves. Obviously, interpolation on a nomogram is accomplished more easily than on a coordinate plot and fewer reading errors are obtained because the eye does not have to distinguish one line from a maze of lines.

The Classification of Nomograms

Nomograms may be classified as either direct-reading or indirect-reading. An indirect-reading nomogram involves the use of one or more reference lines and requires more than one setting of the straight edge to be read whereas a direct-reading nomogram requires but one setting of the straight edge. This series is concerned primarily with direct-reading nomograms, however, the techniques described are also applicable to the other.

Direct-reading nomograms may be further classified by the number of independent variables which are involved. Such nomograms differ as indicated below:

Classification
1. Two independent variables
a. one dependent variable
b. several dependent variables
2. Three independent variables
3. Four independent variables

Combination of Scales and Grids
three scales
four or more scales
one grid and two scales
two grids and one scale

The discussion in this series is concerned primarily with nomograms consisting of one dependent and two independent variables represented by three scales. Most published nomograms are of this type. The procedure used to construct these simple three variable nomograms are directly applicable to those which involve more than three variables.

An example of the type of nomogram consisting of two independent variables and several dependent variables was published by Edmister.[1] This nomogram shows "ideal" vapor-liquid equilibrium constants of fifteen hydrocarbons as a function of temperature and pressure. Another unpublished nomogram of this type has been drawn to show seven properties

Meet the Author

FRANCIS W. WINN is technical director for Fractionation Research, Inc. A chemical engineering graduate from the University of Oklahoma, he joined the company in 1951, following an assignment as assistant chief engineer with Catalytic Construction Corporation. He also has been associated with a number of major oil companies and one time served with the Petroleum Administration for War.

Winn

of petroleum fractions as a function of gravity and average boiling point. In this manner, the properties are related to each other so that knowing the value of two properties, the remaining ones can be determined. Such a nomogram could be broken up into several separate three-variable nomograms, a different nomogram for each of the many possible combinations of the seven properties taken three at a time. Applications for nomograms of this type are not common.

A direct-reading nomogram of one dependent and three independent variables is one involving a grid or network, which represents two of the variables, plus two individual scales for the remaining two variables. An example of such a nomogram, "Slot Opening of Bubble Caps," was published by Winn and Keller.[3]

This nomogram shows the dependent variable, slot opening, as a function of slot dimensions, vapor rate, and properties of the vapor and liquid. It is the nomographic solution of an equation which must be solved by trial and error except for special cases. The equivalent coordinate form is a series of three-variable charts, each one specific for a different value of the fourth variable. Applications for nomograms of this type are found frequently.

A direct-reading nomogram of one dependent and four independent variables consists of two grids and one individual scale. An example of this type, "Presentation of Vapor-Liquid Equilibria" was published by Winn.[4,5] This nomogram consists of an individual "K" scale which is the dependent variable, and a temperature-pressure grid and a component-solvent grid. The nomogram may also be used, in conjunction with a coordinate plot, to bring into account a sixth variable, the convergence pressure.

The corresponding coordinate form of this relationship consists of numerous three-variable coordinate charts, each one specific for one of the many combinations of values of the remaining variables. A set of vapor-liquid equilibrium constants for 12 hydrocarbons in the form of coordinate charts bound in three large volumes was published[2] in 1950.

Fundamentals of Nomography

Scales. A scale is a curved or straight line which is graduated at intervals with short perpendicular marks. Certain of these marks are labled with numbers in an orderly fashion so that any particular point on the scale may be assigned a numerical value. For points which do not coincide with a graduation mark, the value is estimated by interpolation between the two nearest graduation marks.

A scale consists of a stem, graduation strokes, calibration numbers and a legend. Usually a scale represents only one variable. In some cases it may be desirable to graduate both sides to represent different units of the same variable, or with different variables.

The graduation strokes are short straight marks which are perpendicular to and spaced along the stem. The strokes are made short, intermediate, and long in order to facilitate reading and interpolation of the scale. Suggested lengths are $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{3}{16}$ inch for the nomogram in the size in which it will be used.

The spacing interval between graduation marks of a scale should be such that interpolation can be done easily and accurately. An interval of 0.02 to 0.2 inch can be interpolated with very little error. For practical purposes, however, the construction of a graduation interval of less than 0.05 inch should not be attempted because of the difficulty in placing a stroke at such intervals. The finished nomogram having a graduation interval of 0.02 inch can be achieved, if desired, by process of photographic reduction of large scale originals. Graduation intervals of less than 0.02 inch should be avoided.

The subdivision of a major scale interval should be based on the decimal system. The ten-interval subdivision is the most desirable; however, if such a subdivision results in a spacing of the graduation marks of other than from 0.05 to 0.2 inch, the 2, 5, 20, or 50 interval subdivision may be used. The four-interval subdivision is confusing and should be avoided.

The calibration numbers are placed along the scale opposite certain of the long graduation marks in a manner such that the scale may be read with a minimum of confusion. Normally the numbers are spaced on the order of $\frac{1}{2}$ to 2 inches apart. Distances greater than 2 inches require a shifting of the eye to be read and should be avoided. Spacings of less than $\frac{1}{2}$ inch tend to be confusing although it is sometimes unavoidable with non-uniform scales.

The scale legend identifies the variable the scale represents, its symbol, and the units involved. The legend may be placed above or below the scale or parallel to it, which ever is the most convenient. Several scales are illustrated in the examples.

Nomographic Scales, the Equivalents of Coordinate Families of Straight Lines. A scale bears the same relationship to a nomogram that a family of lines bears to coordinate graphical plot. Each family of straight lines of a coordinate plot is represented in its nomographic form by a scale; and, each individual line of the family is represented in its equivalent nomographic form by a particular point or graduation mark on the scale.

A family of straight lines of a coordinate plot which *converges* to a common point is represented in nomographic form by a *straight scale stem*. A family of *straight parallel lines* may be considered as converging at infinity and is also represented by a *straight scale stem*. All other families of lines are represented in nomographic form by curved scale stems.

The most frequently encountered scale is the straight scale which represents a coordinate family of straight parallel lines. Many nomograms consist of at least two such scales, one for the abscissa and one for the ordinate of the equivalent coordinate graph.

The distance between individual graduation marks on the straight scale which represents a coordinate family of parallel lines is directly proportional to the perpendicular distance between the corresponding individual lines of the coordinate family.

Procedure for Construction of a Straight Uniform Scale. A straight uniform scale is, as the name implies, a straight line having an equal spacing between graduation marks. The nomographic equivalent of a family of parallel straight equi-spaced lines of a coordinate plot such as either the ordinate or abscissa of ordinary arithmetic graph paper is a straight uniformly graduated scale. Such a scale of any desired length may be constructed to cover any given range of limits of the variable which it is to

represent by projection from arithmetic graph paper:

1. Fasten a sheet of high quality blank paper to the drawing board. The paper should have a low coefficient of expansion with variation in humidity of the air. Draw the scale stem, a straight line of the desired length, on the blank paper perpendicular to the T-square. Calibrate the ends of the stem with the corresponding upper and lower limits of the variable. This step is illustrated in Figure 1a for an example where it is desired to graduate a scale stem of a specified length, uniformly between the limits of 2 and 7.

2. Fasten a sheet of arithmetic graph paper to the drawing board. The vertical lines of the graph paper do not necessarily have to be perpendicular to the T-square. This step is shown in Figure 1b. To avoid confusion, the horizontal lines of the graph paper have been omitted because they are not necessary in the procedure. (Caution: Some of the inexpensive grades of arithmetic graph paper do not have uniformly spaced rulings.)

3. Number the vertical lines of the graph paper so as to include the range of values represented by the upper and lower limits of the scale stem drawn under Step (1). This is shown in Figure 1b for the example being illustrated. The number sequence may proceed from left to right or vice versa.

4. Project a horizontal line through the upper end of the scale stem extend it (to the right for the example being illustrated) to intersect that vertical line of the graph paper which represents the corresponding upper limit of the scale. Repeat for the other end of the scale stem. Figure 1b illustrates this step with small circles drawn about the two points of intersection.

5. Draw a straight line or transversal on the paper connecting the two points established in Step (4). This line intersects the vertical lines of the graph paper.

6. Project the points of intersecsections of the transversal with the vertical lines of the graph paper horizontally to the scale stem. This results

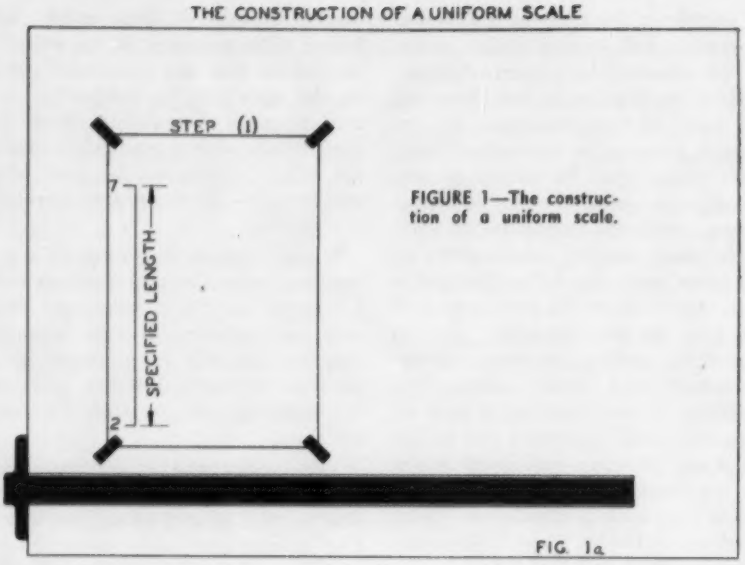


FIGURE 1—The construction of a uniform scale.

FIG. 1a

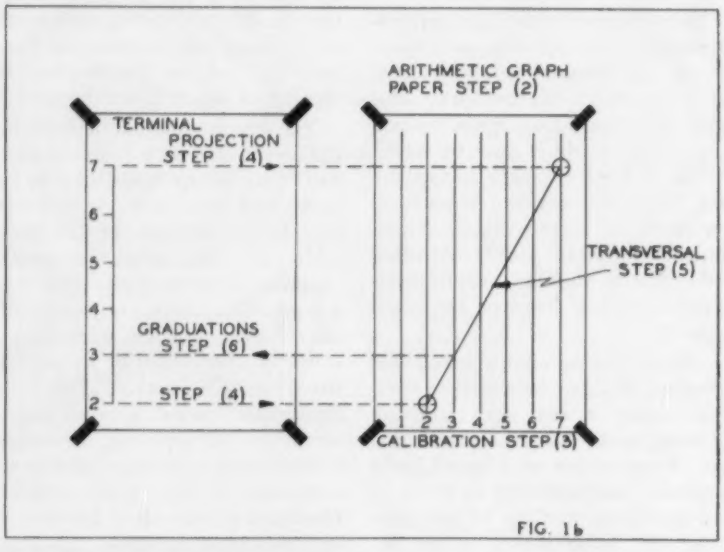


FIG. 1b

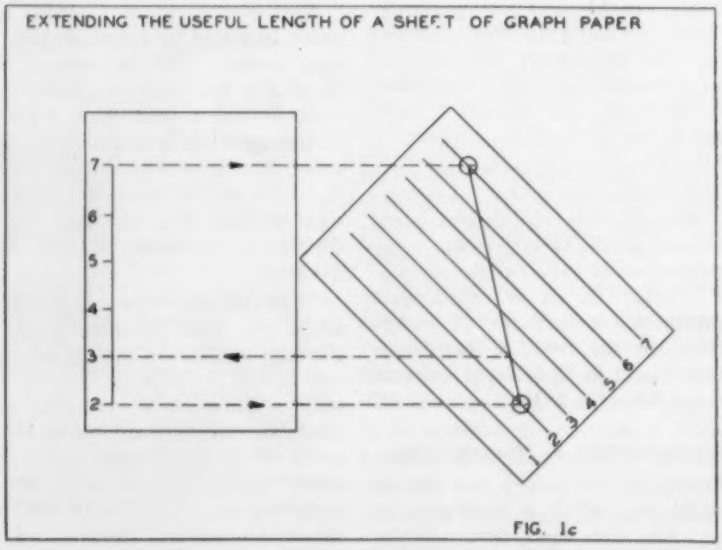


FIG. 1c

in the desired uniform graduation.

The vertical height of a sheet of graph paper can be extended by turning it to an angle with the vertical because the diagonal is longer than the side. This means of extending the height of a sheet of graph paper is frequently useful. Figure 1c is similar to Figure 1b except the graph paper is standing on one of its diagonals. It can be seen that a uniform graduation is obtained regardless of the angle involved.

How to Construct a Logarithmic Scale. A straight logarithmetic scale of any desired length covering any range of limits of the variable it is to represent may be drawn by a procedure similar to that for uniform scales. A sheet of logarithmic graph paper is fastened to the board adjacent to the scale stem which is to be graduated.

It is preferable that the graph paper have a sufficient number of cycles to cover the upper and lower limits of the scale. If such paper is not available, the scale stem can be divided into several segments covering narrower limits.

The vertical lines of the graph paper are numbered and the two terminals of the scale stem are projected horizontally to the corresponding vertical lines of the graph paper. A transversal connecting these points is used to project graduation marks to the scale stem.

Figure 2a illustrates the construction of a logarithmic scale covering the range from 2.0 to 7.0 and Figure 2b covers the limits of 0.6 to 30.

How to Construct Scales from Special Graph Paper. Any family of parallel lines can be converted to its equivalent nomographic scale form by a procedure analogous to that just described. As an illustration, segments from both the viscosity and temperature axes of the ASTM Standard Viscosity-Temperature Chart are shown in Figure 2c.

Part 2 will appear in a coming issue.

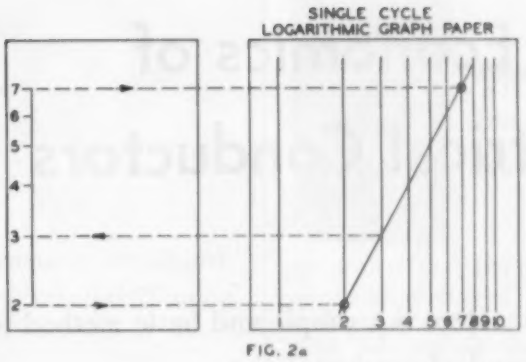


FIG. 2a

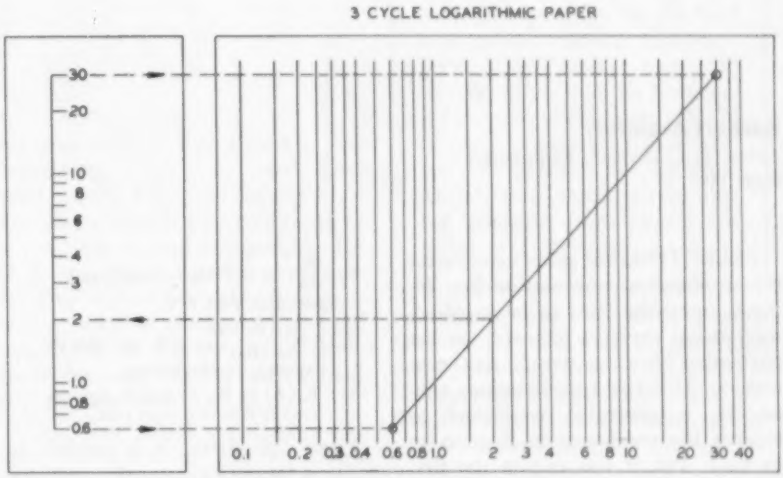


FIG. 2b

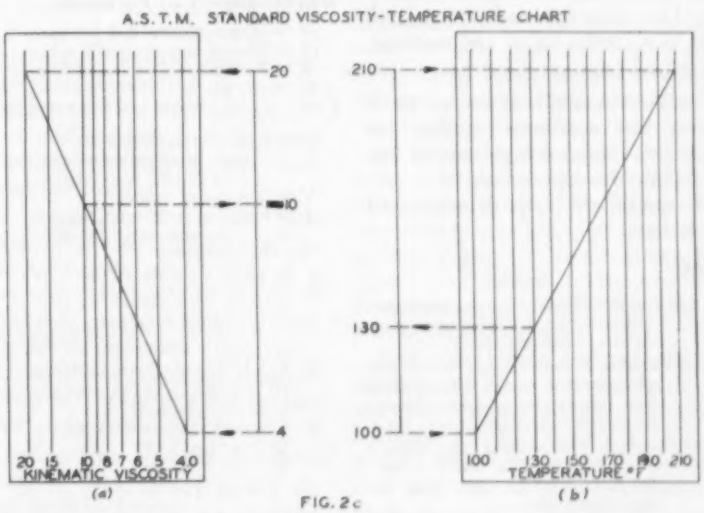


FIG. 2c

FIGURE 2—The construction of logarithmic scales and scales from special graph papers.

LITERATURE CITED

[1] Edmister, W. C., Petroleum Refiner, **28**, 132 (August, 1949).

[2] "Liquid-Vapor Equilibrium in Mixtures of Light Hydrocarbons," M. W. Kellogg Fugacity charts Polyco Data (1950).

[3] Winn, F. W., and Keller, G. J., Petroleum Refiner, **34**, 111 (July, 1955).

[4] Winn, F. W., Chem. Eng. Prog. Symposium Series No. 2, Vol. 48, 121 (1952).

[5] Winn, F. W., Petroleum Refiner, **33**, 131 (June, 1954).

The Economics of Electrical Conductors

Here is a simple and basic method to find the most economical conductor size.

Herbert Argintar,
James P. O'Donnell, Engineers,
New York

SELECTING the proper conductor for an electrical transmission line depends upon the load to be supplied, mechanical strength required for the particular "loading area," and economics. The last consideration, economics, is generally overlooked as regards the conductor in relation to its load. Yet, it was one of the first criterion to be mathematically analyzed. The "formula" results from studies undertaken by Kelvin, and is herein presented for copper conductors. The same approach can be applied to a conductor of any material.

Kelvin's Law as stated is:

The most economical size of transmission line conductor is that for which the annual energy cost of line loss equals the copper cost.

The proof of this is demonstrated as follows:

Proof:

K_1 = Invariable Fixed Charges which are independent of the circuit size. (Poles, hardware, etc.)

K_2 = Variable Fixed Charges which are proportional to the circuit size; i.e., copper size or area. (Insurance, interest, depreciation, etc.)

K_3 = Constant representing the energy cost of the line; i.e., the I^2R loss. It is inversely proportional to the circuit size.

A = Conductor cross-sectional area.

C = Total annual cost of operating the line.

1) $C = K_1 + K_2(A) + K_3/A$

2) $\frac{dC}{dA} = 0 + K_2 - K_3/A^2$, and setting $dC/dA = 0$.

3) $A = \frac{(K_3)_{1/2}}{(K_2)}$, which indicates the economic conductor size.

3a) $K_2(A) = K_3/A$, which equates energy cost to copper cost.

From the above, it is possible to derive a formula expressing conductor size in terms of energy and copper costs. The "formula" is produced as follows:

Development of Formula:

t = Hours of operation per year.
C_e = Cost of energy @ ¢/Kw-Hr.
R = Resistance of annealed copper $\left(= \frac{(10.6)\ L}{A}\right.$, where L = Length of line.$\left.\right)$
C_c = Cost of copper @ ¢/lb.
W = Weight of annealed copper (= 3.03 × 10.6 lb./CM-ft.)
V = Volume of copper
F = Fraction for Fixed Charges (Amortization) (= AL)
I = Load current

1) $\frac{K_2}{A} = \frac{I^2\,Rt.\,C_e}{1000} = \frac{10.6 \cdot L \cdot I^2 t \cdot C_e}{1000 \cdot A}$ Energy Cost

2) $K_2A = W \cdot V \cdot C_c \cdot F = 3.03 \times 10^{-6} \cdot A \cdot L \cdot C_c \cdot F$ Copper Cost

Equating (1) and (2):

3) $10.6\,L \cdot I^2\,t.\,C_e = 3.03 \times 10^{-3} \cdot A \cdot L \cdot C_c \cdot F$

3a) $A = 59 \cdot I \cdot \left(\frac{C_e \cdot t}{C_c \cdot F}\right)^{1/2}$ Copper size required.

In the event that a load is cycled, or varies over a period of time, the load current may be expressed in terms of the effective value of all the individual loads:

3b) $A = 59\left(\frac{C_e}{C_c F}\right)^{1/2} \cdot (I_1^2 t_1 + I_2^2 t_2 + \text{etc.})^{1/2}$ For varying currents.

Comment: Note that length of line, line voltage, etc. is immaterial. The prime concern is copper economics, not electrical characteristics. The use of the formula may be demonstrated by means of a typical problem.

Problem: Determine the economic cable size required for a 96 ampere load operating 365 days per year, 8 hours per day.

Given: Energy costs $0.00875 per Kw-hr. Fixed charges are 23 percent (Investment for 5 years at 3 percent and insurance, taxes, etc.) Copper costs $0.47 per pound.

Solution:

$$A = (59) \cdot (96) \cdot \left(\frac{0.875 \times 365 \times 5}{47 \times 0.23}\right)^{1/2} = 68{,}800 \text{ C. M.}$$

A #2 AWG, with a cross-sectional area equal to 66370 C. M. is the most economical choice. However, the other previously mentioned factors must also be considered before actual selection is made. ##

Meet the Author

HERBERT ARGINTAR is an engineer for James P. O'Donnell, with duties which involve specifications and procurement, design and engineering for refinery electrical service and general utilities. With the company five years and formerly engaged in various chemical and industrial projects, Argintar also has served three years as a member of the electrical-engineering staff at Pratt Institute, and now is preparing two textbooks for the institute, one on D. C. and the other on A. C. machinery. An electrical-engineering graduate from City College of New York, he has completed part of the work on a mechanical-engineering degree from New York University. He is a professional engineer in New York.

This Process Makes Its Own Logsheet

Flows, pressures, and temperatures are simultaneously measured and automatically tabulated on a single sheet.

Howard M. Mathis,
C F Braun and Company,
Alhambra, California

AN AUTOMATIC installation in the Poly Plant Controlhouse at Esso's Bayway Refinery, logs the records of 100 important process variables.

The automatic logger—first of its kind—is based on well-known principles of recording. But it applies features that have not appeared before in commercial operations. The logger records a broad assortment of flows, pressures, and temperatures on a sheet similar to the conventional logsheet. And from cumulative flow-measurements, it computes and prints a record of average flow-rates.

As operating people all know, the logsheet is a valuable source of quick information about the operation of a process unit. The usual procedure is for an operator to go around periodically, read the instruments on the gage board, make some computations, and enter the readings on his logsheet. When the plant is running well, there's no problem. But when things go haywire, the logsheet is likely to be neglected for more pressing duties. This, unfortunately, is just the time when the record is needed most.

The automatic logger relieves the operator of the recording chore. The machine prints the records every hour, or at whatever other regular interval is selected. It is faster and more accurate than manual posting. It prints 100 assorted flows, temperatures, and pressures in less than five minutes. And, at any time between the regular hourly readouts, the operator may order a special readout by pressing a button.

The idea for the Bayway logger was originated by Esso Research and Engineering Company and Esso Standard Oil Company people. C F Braun & Co. installed the equipment as part of their over-all responsibility for the design and construction of the new Cat Poly unit. Since this first logger was somewhat experimental, Esso engineers stipulated that it must not interfere in any way with the conventional operation and control of the plant.

When this initial installation has been proved-out in service, future loggers can be simplified and included as an integral part of the control system. In that case, an automatic logger would add very little to the cost of instrumenting a unit, for the basic idea of the logger is rather simple. Temperature inputs are electrical, transmitted direct from thermocouples. Flow and pressure inputs are conventional 3 to 15-pound air pressures, transmitted from field-mounted instruments.

The pneumatic inputs are converted into electrical impulses at the logger. All inputs then go through a scanner and programming device, to a digital converter and range selector, and finally to automatic typewriters. Fischer and Porter Company designed and built the equipment for the system, which is shown in Figure 1.

The first two process variables, temperature and pressure, are recorded at instantaneous readings, measured at the time of readout. The machine does not attempt to record what happens to these variables between readouts. But to record usable information about the third variable flow, the machine must do something more than record flowrates at intervals. For the logsheet to be most useful, the flow-readings should represent the average flow during the interval between readouts.

The automatic logger computes and prints these average flow-rates. To do so, it must solve several knotty problems. In the first place, flows are measured by orifice meters. An orifice meter actually measures a pressure-differential. Translating the pressure-differential into a flow-reading, involves a square-root function.

In conventional logging the translation is made on a chart graduated with a square-root characteristic. But the automatic logger can't use a pencil and paper. It must extract the square root before it converts the measurement into digits that can be printed on the logsheet.

Next, the logger continuously integrates the flow, and divides it by the time elapsed since the previous readout. In this way, the figure printed always represents the average flow per unit of time, whether the readings are made hourly, every half-hour, or at any other interval.

During a readout cycle, which takes about five minutes, the logger suspends operations, but continues to

Meet the Author

HOWARD M. MATHIS is a project engineer for C F Braun & Company at Alhambra, Calif. With the company since 1946, he has served as a chemical engineer and as a project engineer, and spent time in the field both in construction and engineering. Previously associated with E. I. Du Pont de Nemours & Company at Deepwater, N. J., he now is registered as a professional engineer in California. Mathis is a chemical-engineering graduate from Drexel Institute of Technology.

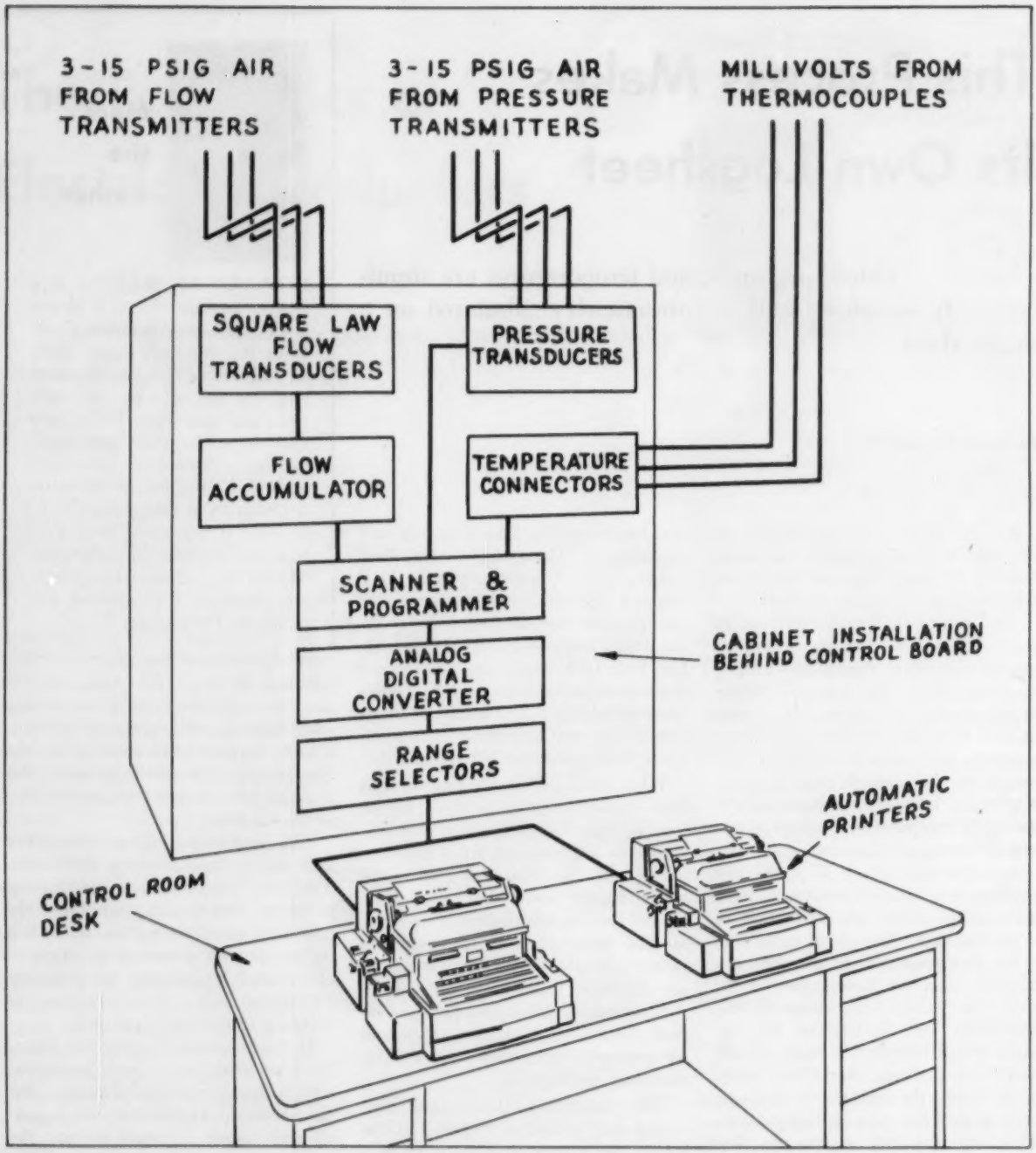


FIGURE 1—This system automatically makes a permanent record of many process variables.

store up the record of flow. There is never a time during which flow is not being measured. After the flows are computed, each is printed in its appropriate units, such as gallons per minute, barrels per day, pounds per hour, or cubic feet per minute.

Up to now, automatic recording has been confined largely to a few industries, and to rather limited applications. Scanning devices and digital converters have been used to record up to several hundred pressures or temperatures, mostly in test work. But these machines usually deal with only one kind of variable—all pressures, say, or all temperatures. They may print the figures on a roll of paper, or punch a tape, or draw curves on a card. It is only recently that the process industries have become interested in the possibilities of automatic logging for complete process units.

Adoption of automatic loggers may soon pave the way for the next logical development in the automation of process units, automatic accounting. With the addition of a simple accessory, an automatic logger could supply punched cards or tapes to duplicate selected figures from among those printed on the logsheet. The cards or tapes could then go to accounting machines, eliminating one more manual operation, with its attendant chance for error. ##

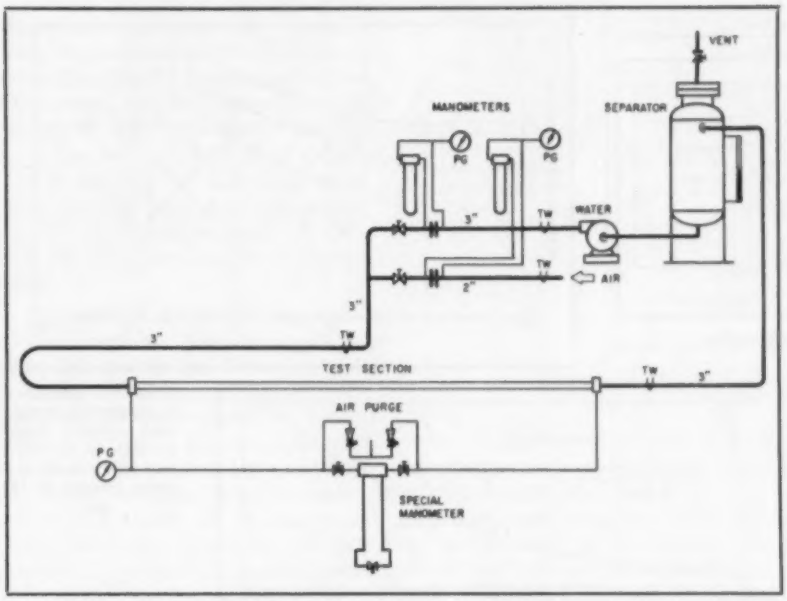


FIGURE 1—Flow diagram of apparatus.

Try this new correlation . . .

Turbulent Two-Phase Flow

Based on 264 runs in larger pipes and at pressures to 100 psia, this correlation gives better results.

J. M. Chenoweth and M. W. Martin,
C F Braun & Company, Alhambra, Calif.

IN MANY industrial plants, gases and liquids flow together in pipes as a two-phase mixture. For example, two-phase mixtures of petroleum fractions pass through fired-heater tubes and transfer line in refineries. Gas and liquid mixtures are circulated together in pipe line contactors in chemical plants. And mixtures of partially condensed vapors flow through condensate lines in steam and refrigeration plants. For all of these cases and many more, the engineer needs to be able to predict pressure drop.

Pressure-drop computations for two-phase flow are more complex than for single-phase flow. The introduction of a second phase causes a sharp rise in the pressure drop because of one or more of the following factors: The cross-section for flow of the one phase is reduced by the introduction of the second. The flow boundary is no longer a relatively smooth pipe wall, but is a rough, irregular, mobile interface between phases. And the introduction of the second phase can cause a very unsteady flow accompanied by intense turbulence.

The many types of two-phase flow further complicate pressure-drop computations. Altogether, seven different types have been observed in horizontal pipes. In order of their appearance with increasing gas rate, they are called bubble flow, plug flow, layered flow, wavy flow, slug flow, annular flow, and misting flow. The transition from one type to another is gradual and the boundary between each is subject to the arbitrary interpretation of the investigator. Alves[1] has given excellent descriptions of each type of flow and has set forth approximate boundaries between types.

The most generally accepted correlation for predicting two-phase flow pressure drop is the method of Lockhart and Martinelli.[2] This method was developed from data for small-diameter pipes and for pressures from atmospheric to 50 pounds per square inch gauge. But many applications of two-phase flow fall beyond these limits. This investigation was undertaken to check the Lockhart and Martinelli correlation with pressure-drop data for two-phase flow in larger pipes and at higher pressures.

Apparatus and Tests—Equipment was set up to get isothermal-flow data for air-water mixtures. Figure 1 shows the arrangement of the test section, the system for mixing and circulating the fluids, and the means for measuring pressures, temperatures, and flow rates. Liquid was circulated by a centrifugal pump capable of delivering 200 gallons per minute at a 50-foot head. Compressed air was available at 125 psig in quantities to 750 scfm. Both streams were metered and the flow rates adjusted by manual control valves. The streams were brought together in a mixing tee with the water flowing down through a 3-inch run and the air entering through a 2-inch branch. The mixture then flowed some 50 feet through a 3-inch supply line before entering the test section. Upon leaving the test section, the mixture flowed to a separator where the air was vented through a pressure-control valve and the water was returned to the pump for recirculation. Two interchangeable test sections were used. One was made from 1½-inch and the other from 3-inch schedule 40, galvanized steel pipe.

Single-Phase Tests—Both test sections were checked with water to determine the single-phase friction factors. Figure 2 shows the experimental friction factors plotted against Reynolds number for the range of 20,000 to 200,000. The 1½-inch test section gave friction factors within plus or minus 7 percent of the smooth-

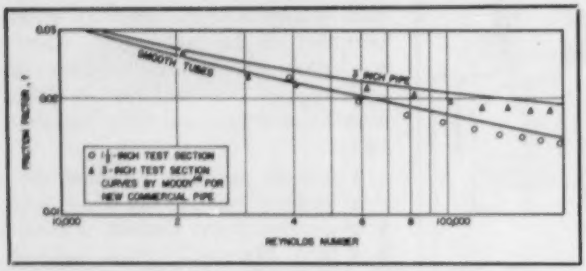


FIGURE 2—Single-phase calibration of test sections.

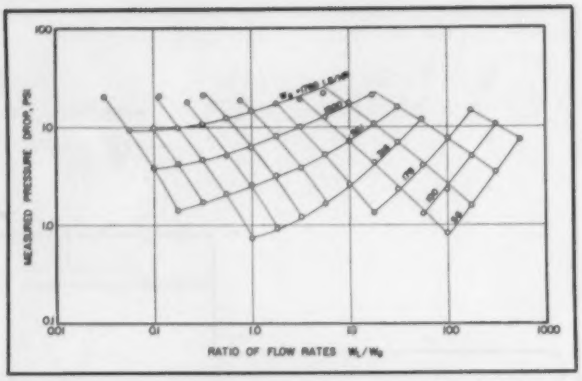
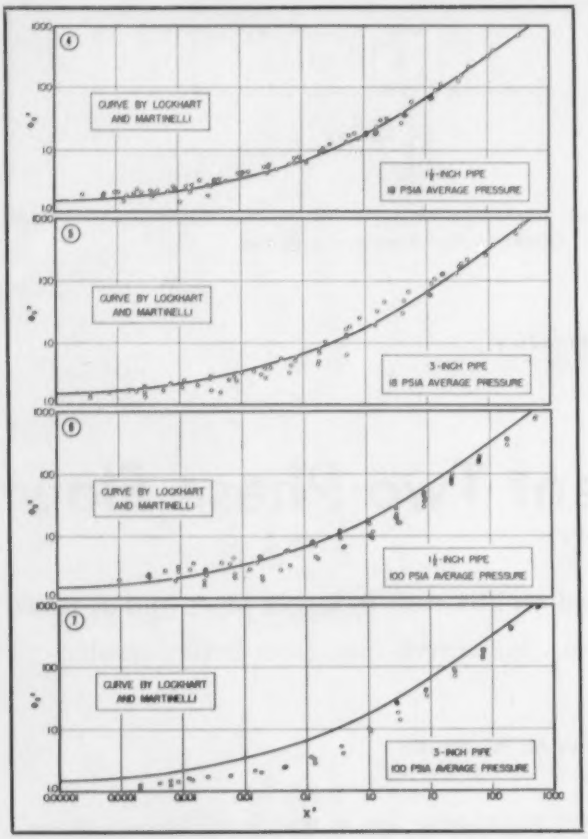


FIGURE 3 (above)—Cross-plot of measured pressure drops for tests in the 1½-inch pipe with an average pressure of 18 psia.

tube curve by Moody.[4] The pipe was new, and the visual inspection showed the pipe to be very smooth. The 3-inch test section gave friction factors about 8 percent below Moody's curve for 3-inch commercial pipe. Again the pipe was new and appeared quite smooth.

Two-Phase Tests—During the experimental program 264 isothermal two-phase pressure-drop tests were made, covering the range of variables listed in Table 1. All of the data were checked for consistency by plotting measured pressure drops versus the ratio W_L/W_G, the liquid to the gas flow rates. Figure 3 is such a plot showing the data for the series of tests made with the 1½-inch pipe near atmospheric pressure. The other test series produced similar plots. From these plots, the pressure drop was found to increase smoothly as either the gas or liquid rate increased. There were no sharp breaks in the curves, even though the tests included layered, wavy, slugging, misting, and annular flows.

Old Correlation—The correlation that has received widest acceptance is the one developed by Lockhart and Martinelli.[2] Their tests were made with air and various liquids flowing through pipes ranging in size from capillaries up to 1 inch diameter, and at pressures from atmospheric up to 50 pounds per square inch gauge. The present data are shown in the Lockhart and Martinelli correlation in Figures 4 through 7.


CURVE BY LOCKHART AND MARTINELLI
1½-INCH PIPE 18 PSIA AVERAGE PRESSURE
3-INCH PIPE 18 PSIA AVERAGE PRESSURE
1½-INCH PIPE 100 PSIA AVERAGE PRESSURE
3-INCH PIPE 100 PSIA AVERAGE PRESSURE
X'

FIGURES 4, 5, 6 and 7 (left)—Test data compared with the turbulent-two-phase curve for the Lockhart and Martinelli correlation.

TABLE 1
Range of Test Conditions

Series*	Investigator	Pipe Size, Inches	FLUIDS	Average Pressure, Psia	Liquid Flow Rate, Lb./Hr.	Gas Flow Rate, Lb./Hr.
1	Authors	1.602	Water and Air	18	100—31,600	56—1,780
2	Authors	1.602	Water and Air	100	100—31,600	56—3,160
3	Authors	3.072	Water and Air	18	100—31,600	56—3,160
4	Authors	3.072	Water and Air	100	100—31,600	56—3,160
5	T. H. M. Taylor	1.017	Diesel Oil and Air	18	2020—4,380	20— 247
6	T. H. M. Taylor	1.017	Kerosene and Air	18	641—12,900	21— 210
7	T. H. M. Taylor	1.017	Water and Air	18	289—15,200	11— 226
8	T. H. M. Taylor	1.017	Water+Nekal and Air	18	450—15,900	15— 248
9	R. W. Ravenscroft	0.622	Water and Air	50	210— 317	41— 99
10	E. G. Thomsen	0.622	Water and Air	52	300	36— 101
11	E. G. Thomsen	0.622	Water+Kemenol and Air	52	191— 315	24— 102
12	E. G. Thomsen	0.622	Benzene and Air	52	141— 273	17— 102
13	A. H. Abou-Sabe	0.870	Water and Air	18	975—15,000	4— 201
14	G. E. Alves	1.049	Water and Air	24	485— 8,400	10— 196

*Series numbers are used for identification in Table 4.

TABLE 2
Comparison of Test Data with Lockhart and Martinelli Correlation

Pipe Size, Inches	Average Pressure, Psia	PERCENT AVERAGE DEVIATION	
		Absolute	Algebraic*
1.602	18	19.2	4.0
1.602	100	38.6	28.9
3.072	18	21.9	— 8.9
3.072	100	75.3	—42.3
All Tests		35.5	—16.7

* Minus sign indicates measured pressure drop is less than predicted pressure drop.

The data for the 1½-inch pipe near atmospheric pressure fall generally along the correlation. All of the points are within plus 28 percent and minus 49 percent, which is within the accuracy of the correlation. On the other hand, the data for the 1½-inch pipe at 100 psia fall below the correlation, for the most part. Several of the measured pressure drops are only half the value predicted by the correlation.

The data for the 3-inch pipe tested near atmospheric pressure again fall along the correlation. The agreement is not as good as for the 1½-inch tests, but all of the data are within plus or minus 60 percent. The data for the 3-inch pipe at 100 psia show the widest deviation from the correlation with almost all of the points falling low. The correlation predicts pressure drops up to 2.5 times as great as those actually measured.

A tabulation of the absolute and algebraic averages of deviation for each series of tests is given in Table 2. The correlation handles some of the flow conditions well, but it fails to handle others.

Improved Correlation—An improved correlation for two-phase pressure drop in horizontal pipes was developed from the test data for 1½-inch and 3-inch pipes. The correlation presented in this paper is empirical, just as all earlier ones have been. It can be used for any two-phase mixture as long as the flow is turbulent, and it predicts single-phase values when the flow is all liquid or all gas.

The correlation uses the liquid volume fraction and two pressure-drop ratios as parameters. Figure 8 show the abscissa as the superficial liquid volume fraction, or LVF, of the mixture computed from the flow rates and densities of the two phases. The superficial LVF may be quite different from the actual LVF since the phases often travel at different velocities. Johnson and Abou-Sabe[5] pointed out that the gas may travel as much as 7 times faster than the liquid. Since the actual LVF is seldom known, the superficial LVF is used for this correlation.

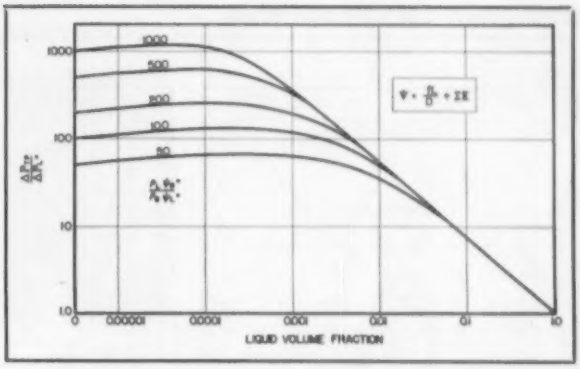


FIGURE 8—Correlation for turbulent two-phase pressure drop in horizontal pipes.

The ordinate of Figure 8 is $\Delta P_{TP}/\Delta P_L^*$, the ratio of the two-phase pressure drop to a fictitious all-liquid pressure drop. The all-liquid pressure drop is computed from the total mass flow $(W_L + W_G)$ and the physical properties of the liquid. The concept of the all-liquid pressure drop is useful as it allows the correlation to be tied into single-phase results at one end and eliminates any ambiguity about the physical properties to use, especially viscosity. Further, the all-liquid pressure drop was chosen over the all-gas pressure drop, because the liquid density generally does not vary in a problem, while the gas density changes with the pressure. Thus, only one single-phase pressure drop need be computed.

On the grid are plotted a family of curves for the parameter $\rho_L\psi_G^*/\rho_G\psi_L^*$, where $\psi = fL/D + \Sigma K$. The parameter is equal to the ratio of the fictitious all-gas to all-liquid pressure drops for the pipe system.

$$\frac{\Delta P_{G^*}}{\Delta P_{L^*}} = \frac{\left[\frac{f_{G^*}L}{D} + \Sigma K\right]\left[\frac{W_L + W_G}{A}\right]^2\left[\frac{1}{2g\,\rho_G}\right]}{\left[\frac{f_{L^*}L}{D} + \Sigma K\right]\left[\frac{W_L + W_G}{A}\right]^2\left[\frac{1}{2g\,\rho_L}\right]} \qquad (1)$$

The subscripts with asterisks, L* and G*, refer to the fictitious all-liquid and all-gas flows, respectively, and the subscripts without asterisks, L and G, refer to the actual liquid and gas flows. Canceling out like terms in the equation and substituting

$$\frac{\Delta P_{G^*}}{\Delta P_{L^*}} = \frac{\left[\frac{f_{G^*}L}{D} + \Sigma K\right]}{\left[\frac{f_{L^*}L}{D} + \Sigma K\right]}\,\frac{\rho_L}{\rho_G} = \frac{\psi_{G^*}\,\rho_L}{\psi_{L^*}\,\rho_G} \qquad (2)$$

The friction factors are those from the Moody chart[4] for single-phase flow plotted against Reynolds number. To determine the Reynolds number for f_{L^*}, the sum of the flow rates and the physical properties of the liquid phase are used

$$Re_{L^*} = \frac{DG}{\mu_L} = \frac{D\,(W_L + W_G)}{\mu_L A} \qquad (3)$$

For f_{G^*} the physical properties of the gas phase are used. The K's are the friction coefficients for valves and fittings. A complete list of values is given in The Tentative Standard of the Hydraulic Institute.[6] The coordinates for the correlation are listed in Table 3.

The correlation covers all turbulent two-phase mixtures and ties into single-phase values at either end. When the flow is all liquid, the LVF equals 1.0 and the ratio $\Delta P_{TP}/\Delta P_{L^*}$ is also equal to 1.0. On the other hand, when the flow is all gas, the LVF is zero and the ratio $\Delta P_{TP}/\Delta P_{L^*}$ is equal to $\Delta P_G/\Delta P_{L^*}$, so the pressure drop equals $\Delta P_{L^*} \times \Delta P_G/\Delta P_{L^*} = \Delta P_G$

Two-phase pressure drops predicted by this correlation are plotted against measured pressure drops in Figure 9. Over 92 percent of the calculated ΔP are within 35 percent of the measured values and all are within 50 percent. The deviation for each point was com-

TABLE 3

Coordinates for Proposed Correlation

	$\Delta P_{TP}/\Delta P_L^*$				
	$\rho_L\psi_G^*/\rho_G\psi_L^*$				
LVF	50.0	100	200	500	1000
0	50.0	100	200	500	1000
.00001	56.5	113	225	565	1125
.00002	58.5	117	235	585	1175
.00004	62.0	124	248	620	1230
.00007	63.5	127	254	635	1200
.0001	64.5	129	258	645	1150
.0002	66.0	132	255	580	950
.0004	67.5	129	249	470	680
.0007	65.0	121	219	385	470
.001	62.0	115	199	325	370
.002	58.0	99.0	153	215	215
.004	50.0	82.0	105	120	120
.007	41.0	60.0	71.0	72.5	72.5
.01	34.5	48.0	53.0	53.0	53.0
.02	24.0	29.2	29.2	29.2	29.2
.04	15.0	16.1	16.1	16.1	16.1
.07	9.90	9.90	9.90	9.90	9.90
.10	7.40	7.40	7.40	7.40	7.40
.20	4.05	4.05	4.05	4.05	4.05
.40	2.22	2.22	2.22	2.22	2.22
.70	1.38	1.38	1.38	1.38	1.38
1.00	1.00	1.00	1.00	1.00	1.00

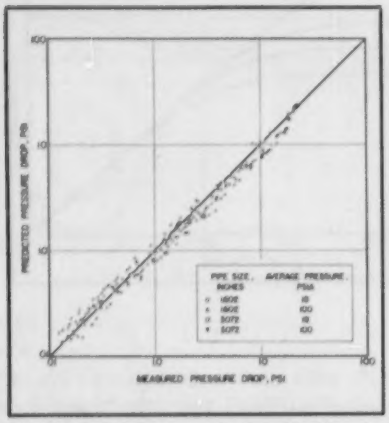


FIGURE 9—Test of correlation with data for horizontal pipe.

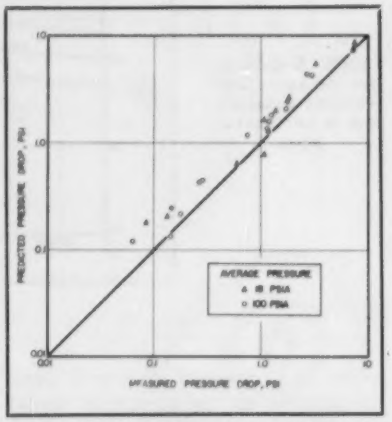


FIGURE 10—Test of correlation with data for a piping system containing an orifice. Pressure taps were located 38 diameters upstream and 38 diameters downstream of orifice. Single-phase friction coefficient for the orifice alone was 18.3.

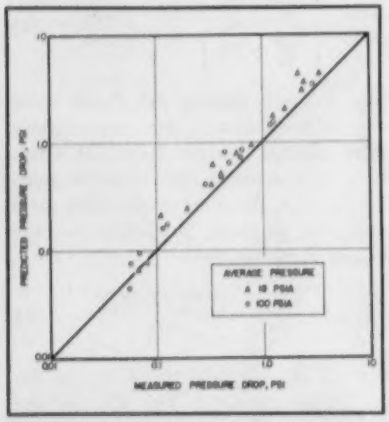


FIGURE 11—Test of correlation with data for a piping system containing a glove valve. Pressure taps were located 38 diameters upstream and 38 diameters downstream of the valve. The single-phase friction coefficient for the valve alone was 5.3.

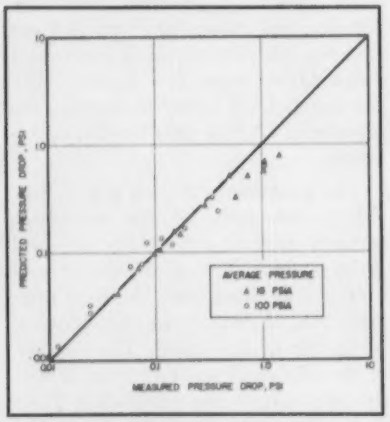


FIGURE 12—Test of correlation with data for piping system containing a long radius return bend. Pressure taps were located 10 diameters upstream and 30 diameters downstream of return bend. Single-phase friction coefficient for return bend alone was 0.3.

puted, and the absolute and the algebraic average of the deviations determined. The average of the absolute deviations is 19 percent while the algebraic average is 0.7 percent.

The correlation also fits the test results of other investigators. Table 4 lists the deviations from the isothermal turbulent-turbulent data of Johnson and Abou-Sabe,[5] Alves,[1] and those used by Lockhart and Martinelli[2] for developing their correlation. In all instances the average deviation of test data from the correlation is less than 30 percent. The over-all average of the absolute deviations is 20 percent and the algebraic average of the deviations is 5 percent. These results are for 506 different test runs in pipes from ½ to 3 inches diameter, pressures from atmospheric to 100 psia, and fluid-systems including air with water, kerosine, benzene, and diesel oil.

The correlation can be used to design most horizontal two-phase lines found in industrial plants. The only limitation is that the all-liquid Reynolds number must be greater than 2000. For flows with Reynolds numbers less than 2000 the correlation will, in general, predict pressure drops that are higher than actually exist.

The correlation is based on isothermal tests where there is no change of state as the mixture flows through the test section. The results, however, can be used to determine the the two-phase pressure drop for condensation and vaporization by a stepwise solution using point values taken from the correlation. The correlation is convenient to use for these problems as only one single-phase pressure drop need be computed. The results can then be multiplied by the proper $\Delta P_{TP}/\Delta P_{L\theta}$ as the LVF changes. It must be pointed out that the correlation gives only the friction pressure drop. Where there is a change of phase the pressure drop due to acceleration must also be considered.

Fittings—Piping systems include valves and fittings as well as lengths of straight pipe. Since very little information has been published on pressure losses for two-phase flow through fittings, several representative 3-inch fittings were tested. These included a

TABLE 4

Comparison of Test Data with Correlation

Series*	Investigator	Pipe Size, Inches	Average Pressure, Psia	Number of Tests	PERCENT AVERAGE DEVIATION	
					Absolute	Algebraic
1	Authors	1.602	18	71	14.9	0.1
2	Authors	1.602	100	74	19.9	4.8
3	Authors	3.072	18	71	23.2	—1.2
4	Authors	3.072	100	48	18.5	—9.8
				264	19.0	—0.7
5	T. H. M. Taylor	1.017	18	23	22.3	—22.3
6	T. H. M. Taylor	1.017	18	39	15.6	—12.2
7	T. H. M. Taylor	1.017	18	43	20.1	18.7
8	T. H. M. Taylor	1.017	18	26	22.9	16.5
9	R. W. Ravenscroft	0.622	50	9	21.8	20.7
10	E. O. Thomsen	0.622	52	7	20.8	20.8
11	E. O. Thomsen	0.622	52	19	25.7	25.7
12	E. O. Thomsen	0.622	52	23	25.2	24.4
13	A. H. Abou-Sabe	0.870	18	31	26.7	26.7
14	G. E. Alves	1.049	24	22	22.6	4.4
				242	22.0	14.1
	For All Tests			506	20.4	6.4

*Series numbers are used for identification in Table 1.

composition-disk globe valve, a sharp-edge orifice with a diameter ratio of 0.55, and a long-radius return bend. Each fitting in turn was installed between the two halves of the 3-inch test section. Pressure drops were measured across the straight pipe and fitting so that all turbulence introduced by the fitting would be included. Both single-phase and two-phase tests were made with each fitting. The two-phase tests covered a wide range of flow rates for pressures from near atmospheric to 100 psia.

The measured pressure drops for the pipe and fitting are compared in Figures 10, 11, and 12 with pressure drops predicted by the proposed correlation using single-phase friction coefficients. In general, there appears to be a trend in the deviations. For the sections with the orifice and the globe valve, the predicted pressure drops are higher than measured values. These fittings promote mixing. On the other hand, for the section with the return bend, predicted pressure drops are often lower than measured values. In return bends the phases separate by centrifugal action. The data of Alves[1] show a similar trend for a 1-inch vertical return bend.

Although the trend is present, almost all of the predicted pressure drops agree within plus or minus 50 percent of measured values. Thus the correlation can be used to predict pressure drop for systems containing fittings by using single-phase friction coefficients.

Meet the Authors

Chenoweth

Martin

JAMES W. CHENOWETH has been a research engineer with C. F. Braun & Company since he received his doctor's degree from Purdue University in 1952. His specialties during this time have been in fluid mechanics and electronic-computer methods. Dr. Chenoweth also completed his bachelor's and master's degree at Purdue.

•

MERRITT W. MARTIN, formerly a group leader in the Research department of C. F. Braun & Company, now is with the Chemical Engineering department. While engaged in research for Braun, he gained six years' experience in problems of heat transfer and fluid flow. Holder of a master's degree in chemical engineering from the University of Texas, he worked three years on process development with The Dow Chemical Company.

Summary

1. Pressure drops have been measured for a wide range of two-phase flow conditions in horizontal pipes. The tests were made in 1½ and 3-inch pipes using air and water at pressures from atmospheric to 100 psia.

2. The data are compared with the Lockhart and Martinelli correlation. Best agreement is found for performance at atmospheric pressure. The largest deviations are for data taken at 100 psia in the 3-inch pipe. In this case, the predicted pressure drop is higher than the observed by a factor ranging from 1.4 to 2.5.

3. The test results were used to develop an improved correlation for turbulent two-phase flow in horizontal pipes. The correlation represents all of the experimental data within plus or minus 50 percent, and 92 percent of the data within 35 percent. The data of many other investigators correlate equally well. Coordinates for the correlation are listed in Table 3.

4. The test results for three typical 3-inch fittings show that single-phase friction coefficients can be used satisfactorily in the correlation for predicting the two-phase pressure drop.

Presented at the ASME Petroleum Mechanical Engineering Conference in New Orleans, La., September 25-28, 1955.

Nomenclature

The following nomenclature is used in this article:

A — cross-sectional area of pipe, square feet

D — pipe diameter, feet

f — friction factor for Fanning equation, dimensionless

g — acceleration constant due to gravity, ft/sec²

G — mass flow rate, lb(mass)/sec ft²

K — friction coefficient for a valve or fitting, dimensionless

L — length of pipe, feet

R — bend radius, feet

Re — Reynolds number, dimensionless

W — flow rate of fluid, lb(mass)/sec

ΔP — pressure drop, lb(force)/ft²

μ — viscosity, lb(force)/ft sec

ρ — density, lb(mass)/ft³

ϕ — ratio $\sqrt{\Delta P_{TP}/\Delta P_{SP}}$, dimensionless. Ordinate for Lockhart and Martinelli correlation

X — ratio $\sqrt{\Delta P_l/\Delta P_g}$, dimensionless. Abscissa for Lockhart and Martinelli correlations.

ψ — Dimensionless group equal to $\frac{fL}{D} + \Sigma K$.

Subscripts

g — actual gas flow in total pipe cross section, used in Lockhart and Martinelli correlation

G — actual gas flow

G* — fictitious all-gas flow

l — actual liquid flow in total pipe cross section, used in Lockhart and Martinelli correlation

L — actual liquid flow

L* — fictitious all-liquid flow

SP — single-phase

TP — two-phase

tt — turbulent-turbulent flow, used in Lockhart and Martinelli correlation

LITERATURE CITED

[1] "Co-Current Liquid-Gas Flow in a Pipe-Line Contactor," by G. E. Alves, presented before American Institute of Chemical Engineers Meeting, San Francisco, Calif., 1953.

[2] "Proposed Correlation of Data for Isothermal Two-Phase, Two-Component Flow in Pipes," by R. W. Lockhart and R. C. Martinelli, Chemical Engineering Progress, Vol. 45, 1949, pp. 39-48.

[3] "Fluid Meters, Their Theory and Application, Part I," ASME Special Research Committee on Fluid Meters, 4th ed., 1937.

[4] "Friction Factors for Pipe Flow," by L. F. Moody, Trans. ASME, Vol. 66, 1944, pp. 671-684.

[5] "Heat-Transfer and Pressure Drop for Turbulent Flow of Air-Water Mixtures in Horizontal Pipe," by H. A. Johnson and A. H. Abou-Sabe, Trans. ASME, Vol. 74, 1952, pp. 977-987.

[6] "The Tentative Standard of Hydraulic Institute, Pipe Friction," 90 West Street, New York, N. Y., 1948.

FIGURE 1—The hoop-lift, new, simple, inexpensive attachment for small fork-lift trucks.

Move Drums Easily

A. J. Bevevino,
L. Sonneborn Sons, Inc.,
New York

L. SONNEBORN SONS' Daugherty refinery gradually is eliminating the manual wheeling, loading and double-decking of filled drums in boxcars and trucks through the use of a new, simple and inexpensive attachment for small fork-lift trucks.

It was considered important at this refinery to reduce not only the cost of moving drums but also to reduce the cost of loading filled drums into trucks and boxcars, particularly when double-decking was required. A device was wanted which would allow an operator to transport drums from the point of filling to a boxcar, position the drums in the car, and double-deck if necessary. When this problem first arose, all of this handling was done in a rather primitive way. The drums were taken to the boxcar by means of a hand truck and positioned manually on the car floor. For double-deck loads, the filled drums had to be rolled up an inclined plane and upended to make a second tier. These manual operations have now been largely eliminated by using fork-lift trucks equipped with "hoop-lift" attachments.

The hoop-lift, shown in Figure 1, is a new device which is essentially a frame made of two 3½ x 5-inch angle irons on which is secured a half-circle steel hoop that can be pivoted through approximately 180 degrees around a horizontal axis by the action of lever which is operated by hand or by foot. Three 2-inch grab rings, bent in a quarter-circle, are mounted on the frame and on the inside of the hoop. The complete hoop attachment is bolted to the hydraulic lift of the fork-lift truck as a single unit and replaces the forks.

In use, the truck approaches a drum with the hydraulic lift down and the hoop in an upright position. When the two grab rings on the frame contact the drum, the operator drops the hoop over the drum by pushing the hoop-lever with his foot. The hoop is then raised by the upward movement of the truck's hydraulic lift. The flat bands on the hoop and the frame engage and grip the drum at the rolling hoops and raise it to a convenient height. As soon as the drum is free of the floor, the operator places the truck in motion and so transports the drum to its destination.

At the Daugherty refinery, trucks equipped with such a hoop-lift are utilized to transport filled drums from the points of filling to boxcars and to trucks. When loading drums in a single tier, the operator lowers the drum to the floor of the car or truck just before the exact loading spot is reached, without completely stopping his forward motion. The instant the drum rests on the floor the hoop is rotated free of the drum by means of the hoop-lever. With the truck still in motion, the drum is nudged by the two quarter-circle bands into the exact loading position. Double or triple decking of drums is performed in the same manner as above except that, in these cases, the exact positioning is completed manually.

The hoop-lift attachment on fork trucks has reduced labor costs and has eliminated the unsafe manual method of double-decking. One operator with a hoop-lift truck can transport and load as many drums as two men can with hand trucks. The monetary saving will vary with the locality and type of operation, but in general, each truck with a hoop-lift eliminates the cost of one employe.

The hoop-lift is patented (USP 2,473,410) and available on a license basis. It is very simple mechanically and costs less than $100, exclusive of license fee. The device should prove valuable to shippers of steel drums by reducing drum-handling costs. ##

New Method for Pipe Stresses

Here's how to save time in computing stresses in a three-dimensional piping system:

Part 1. How to Use the Tabular Method
Part 2. Systems with Different Moments of Inertia
Part 3. How to Handle Elbows and Bends

K. Hao Hsiao,
The Ralph M. Parsons Company,
Los Angeles

THE TABULATION method presented here saves hours without sacrificing accuracy in piping stress calculations. The proportion of simplification increases with the number of pipe branches in a system. It also eliminates the necessity of locating the centroidal axes of a system and the centroids, ends and joints of its different branches with respect to these axes in three perpendicular planes (in addition to an isometric view), for calculations of bending moments and torques about these points. The analyst requires only one isometric view, where such locations are unnecessary. This method also simplifies the placing of signs, thereby reducing the chances for errors to a minimum, and resolves itself into a method of automatic substitutions and simple arithmetic operations in tables.

By applying ratios of cross-sectional moments of inertia to systems with different pipe branches, the same basic equations may be used for solution of forces acting at the centroid of a system with constant or different moments of inertia. By tabulating the coordinates of centroids of elbows and their products in the same way as the coordinates of straight pipe branches and their products, the procedure of tabulation and calculation are almost identical for systems containing only straight branches and systems containing both straight branches and elbows. Thus, by using this method an analyst can calculate the stresses in any one of the above systems almost as expediently as the simplest system, i.e., the system with constant cross-sectional moment of inertia and without any elbow.

In this method the moments and products of inertia of any system are calculated directly from the coordinates of centroids of individual pipe branches with respect to any set of arbitrarily chosen axes. This eliminates calculating the line inertia values with respect to the true centroidal axes of the system. The arbitrarily chosen axes can be placed in such a way that many of the coordinates to be listed are equal to zero, so the calculations for these coordinates become unnecessary.

According to the conventional method, one centroidal moment of inertia for each straight branch is tabulated twice; two centroidal moments of inertia are tabulated twice, and one centroidal product of inertia once, for each elbow. Thus, a system containing 5 straight branches and 4 elbows requires the tabulation of 30 centroidal values. This number increases with the number of pipe branches. In this method, however, a maximum of six summarized centroidal values needs to be tabulated for a system of any shape and any number of branches.

Tables 1, 2 and 3 appear on the following pages with data from Example 1 written in. Three numerical examples appearing in parts 1, 2 and 3 of this series are given for piping systems with constant and different moments of inertia, and a system containing quarter bends. In the last example the table for line inertias is applied to a three-dimensional system and a single-plane system. Then, the author shows how to adapt this table to any single-plane system in general, i.e., a system not subjected to displacement perpendicular to its own plane. While the forces,

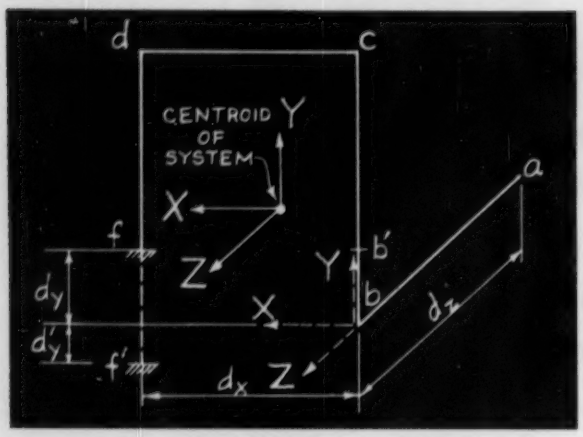


FIGURE 1—Piping system with a constant moment of inertia.

moments and stresses for simple single-plane systems can be calculated with minimum effort from tables given in many piping stress books, the aforementioned table for single-plane systems is most efficient for cases where the number of branches is great, or where the net expanding length for a system in any direction is different from the true length of the system in the same direction.

Piping System With Constant Moment of Inertia

A piping system with constant moment of inertia is shown in Figure 1.

For purpose of computation, we assume end f as fixed and end a in expansion. The forces X, Y and Z, which resist this expansion at a, are transferred to the centroid of the system which is behind the bcdf plane. These forces are shown in opposite directions to expansion but in the same directions as the centroidal axes. The dotted lines at b represent the original "arbitrarily" chosen axes, which will be used instead of the centroidal axes for computation of line inertias and will be explained later.

The fundamental equations for solution of X, Y and Z forces acting at the centroid of the system, caused by thermal expansion can be derived from the Elastic Energy Theory. These are

$$XI_x - YI_{xy} - ZI_{xz} = \frac{\Delta xEI}{1728} \quad (1)$$

$$-XI_{xy} + YI_y - ZI_{yz} = \frac{\Delta yEI}{1728} \quad (2)$$

$$-XI_{xz} - YI_{yz} + ZI_z = \frac{\Delta zEI}{1728} \quad (3)$$

$$\Delta x = \frac{d_x e}{100}, \Delta y = \frac{d_y e}{100}, \Delta z = \frac{d_z e}{100} \quad (4)$$

Where

I_x, I_y, I_z = moments of inertia of the piping system about its centroidal axes. (ft.[4])

I_{xy}, I_{xz}, I_{yz} = products of inertia of the system about the same axes. (ft.[4])

$\Delta x, \Delta y, \Delta z$ = total thermal expansion of the system in the X, Y, and Z directions respectively. (inches)

E = modulus of elasticity of the piping material at operating temperature. (pounds per square inch.)

I = moment of inertia of the cross-sectional metal area of the pipe. (in.[4])

d_x, d_y, d_z = net lengths of the piping system which expand in X, Y, and Z directions respectively.

e = thermal expansion in 100 feet of pipe due to a rise from installation temperature to operating temperature. (inches.)

Substituting Eq. (4) in Eqs. (1), (2), and (3), the right hand terms of the latter become $\frac{d_x eEI}{172{,}800}$, $\frac{d_y eEI}{172{,}800}$ and $\frac{d_z eEI}{172{,}800}$. Substituting an expansion factor $c^* = \frac{eE}{172{,}800}$ in these terms, and dividing Eqs. (1), (2) and (3) by line inertias I_x, I_{xy}, and I_{xz} respectively, we obtain

$$X - Y\frac{I_{xy}}{I_x} - Z\frac{I_{xz}}{I_x} = \frac{d_x cI}{I_x} \quad (5)$$

$$-X + Y\frac{I_y}{I_{xy}} - Z\frac{I_{yz}}{I_{xy}} = \frac{d_y cI}{I_{xy}} \quad (6)$$

$$-X - Y\frac{I_{yz}}{I_{xz}} + Z\frac{I_z}{I_{xz}} = \frac{d_z cI}{I_{xz}} \quad (7)$$

The coefficients in the above equations are obtained in Table 1 and are designated with the following lettered circles, which eliminate the necessity of handling large figures of line inertia values themselves.

$$L = \frac{I_{xy}}{I_x} \quad M = \frac{I_{xz}}{I_x} \quad N = \frac{d_x cI}{I_x}$$

$$P = \frac{I_y}{I_{xy}} \quad Q = \frac{I_{yz}}{I_{xy}} \quad R = \frac{d_y cI}{I_{xy}} \quad (8)$$

$$S = \frac{I_{yz}}{I_{xz}} \quad T = \frac{I_z}{I_{xz}} \quad U = \frac{d_z cI}{I_{xz}}$$

If the fixed point with respect to expansion in Figure 1 is changed from f to f' due, for instance, to the upward expansion of a vessel at the same temperature, connected to the system at f and anchored at f', then the net expanding length in Y direction is d'_y instead of d_y, and the direction of the force Y is reversed. The flexibility of the system, however, is not changed, so that the same length "df" is used in line inertia calculations. If the above vessel is at a different temperature, its thermal expansion e' and c' are different from those of the piping. In this case, denoting length with l, $l_{bb'}c - l_{ff'}c'$ should be substituted for $d_y c$ in Eq. (6). The total expansion in Y-direction is then, from Eq. (4),

$$\Delta y = \frac{1}{100}(l_{bb'}e - l_{ff'}e') \quad (9)$$

Eq. (4) or Eq. (9) are used for calculation of actual ex-

Meet the Author

K. HAO HSIAO received B.A. and M.A. degrees from Stanford University. Following graduation he was employed in the Mechanical Engineering department of Ohio State University. He later worked with Aluminum Limited in Montreal and as a stress engineer with Canadair Limited in the same city. He was also employed by Stadler, Hurter & Company, consulting engineers. He is now a structural designer with Ralph M. Parsons Company in Los Angeles.

[4] Numerical values of "c" are given in "Piping Stress Calculations Simplified," S. W. Spielvogel, p. 93.

pansions in a system for purpose of determining "cold spring," but are not required in the tables presented herewith.

According to the procedure of calculation in Table 1, the moments and products of inertia of a piping system are calculated directly by using the original arbitrarily chosen axes. This procedure is based on the following equations:

Plane	Equation
	i = All Branches; i = Bran. ⊥ Plane
X - Y	$I'_x = \sum l_i y_i^2 + 0.3 \sum l_i y_i^2 - \bar{y}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	$I''_x =$ same as above
X - Y	$I'_y = \sum l_i x_i^2 + 0.3 \sum l_i x_i^2 - \bar{x}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
X - Z	$I'_z =$ same as above
X - Z	$I''_z = \sum l_i z_i^2 + 0.3 \sum l_i z_i^2 - \bar{z}^2 \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	$I''_y =$ same as above
	$I_{oz} = \frac{1}{12} \sum (l_y^2 + l_x^2)$
	$I_{oy} = \frac{1}{12} \sum (l_z^2 + l_x^2)$
	$I_{ox} = \frac{1}{12} \sum (l_z^2 + l_y^2)$
	$I_x = I'_x + I''_x + I_{ox}$
	$I_y = I'_y + I''_y + I_{oy}$
	$I_z = I'_z + I''_z + I_{oz}$
	i = All Branches; i = Bran. ⊥ Plane
X - Y	$I_{xy} = \sum l_i x_i y_i + 0.3 \sum l_i x_i y_i - \bar{x}\bar{y} \left[\sum l_i + 0.3 \sum l_i \right]$
X - Z	$I_{xz} = \sum l_i x_i z_i + 0.3 \sum l_i x_i z_i - \bar{x}\bar{z} \left[\sum l_i + 0.3 \sum l_i \right]$
Y - Z	$I_{yz} = \sum l_i y_i z_i + 0.3 \sum l_i y_i z_i - \bar{y}\bar{z} \left[\sum l_i + 0.3 \sum l_i \right]$

(10)

Where

x, y, z = coordinates of the centroid of each piping branch with respect to the original arbitrarily chosen X, Y and Z axes.

$\bar{x}, \bar{y}, \bar{z}$ = coordinates of the centroid of the piping system with respect to the original arbitrarily chosen X, Y and Z axes.

l = length of each piping branch.

l_x, l_y, l_z = lengths of piping branches parallel to X, Y and Z axes respectively.

I_{ox}, I_{oy}, I_{oz} = sums of centroidal moments of inertia of the above lengths about their own respective neutral axes.

The same "i" is used over the summation signs of all terms in each column in Eq. (10). For clarity of presentation, it is given only over the summation sign for I'_x and I_{xy} and is not repeated for terms below them.

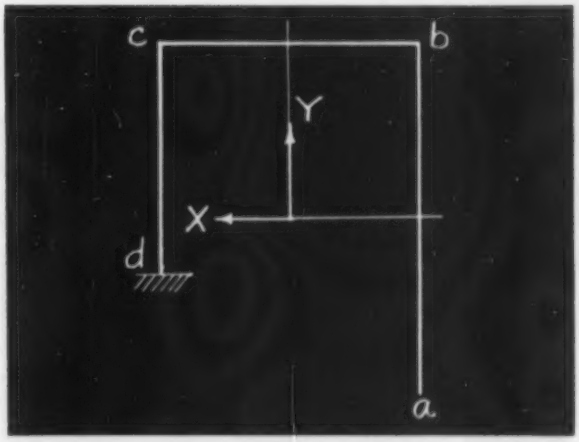


FIGURE 2—Single plane piping system: X and Y axes pass through the the individual centroids of least two branches.

The procedure indicated in Eq. (1) eliminates the necessity of tedious and error-prone process of locating in three perpendicular planes (in addition to an isometric view): (1) the true centroidal axes of the piping system, (2) the coordinates with respect to these axes of individual centroids of different piping branches (for calculation of line inertia values), and (3) the coordinates of ends and joints between the piping branches (for calculation of moments and torques). Therefore, in addition to the simplification in numerical calculations, the resulting procedure of calculations in accordance with Table 1 requires only a simple isometric view of the system, where such locations are unnecessary.

Table 1 contains a "Basic Table," in which are listed the numerical values of the centroid coordinates x, y and z and length l of each piping branch, their products and their respective "Basic Sums." [See Table 1, row (1).] Then the values for branches in torsion in each perpendicular plane is increased by 30 percent to take into account their torsional effect on flexibility [See rows (2), (3), (7), (8), (12), 13)], resulting in different final values for each plane. These final values are used to compute locations of centroidal axes, line inertia values and the ratios of these inertia values in Eqs. (8) [See row (20)]. These ratios are to be inserted in Table 2 for solution of X, Y, and Z forces indicated in Eqs. (5), (6), and (7).

The arithmetic operations are given in the left-hand margin of Table 2, and are self-explanatory. These forces are then inserted in Table 3 to calculate the moments and torques about each end or joint of the piping system. Thus, there are two moments for each end or joint in each plane as indicated in rows (1), (2), (3), (4), (5), and (6) of Table 3.

The signs of these moments are obtained from the directions of the X, Y and Z forces and the signs of their moment arms, i.e., $x - \bar{x}$, $y - \bar{y}$ and $z - \bar{z}$ by means of

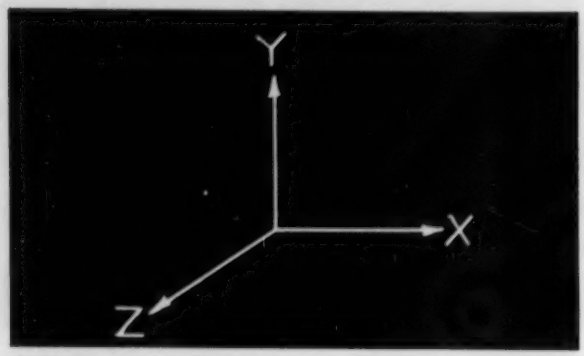


FIGURE 3—Three dimensional analysis: Apply right palm rule for signs.

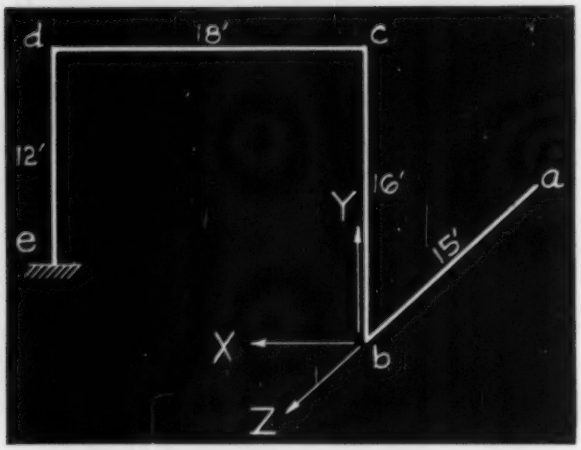


FIGURE 4—Piping system with constant cross-sectional moment of inertia, I = 160.8 in.⁴

the "Right Palm Rule," (stated later). The algebraic sum of these moments in each plane gives the resultant moment in that plane, i.e., M_{xy}, M_{xz} or M_{yz}. Two of the resultant moments are bending moments, from which the combined bending moment and bending stress can be obtained. The third moment is actually a torque, from which the torsional stress can be found.

While the number of rows in the "Basic Table" increases with number of pipe branches, the remaining portion of Table 1 contains exactly the same number of rows or figures regardless of the shape or number of branches in a system. Thus, doubling the number of branches only increases the number of rows in the "Basic Table" to twice its original number. In other words, if the number of branches is increased from five to ten, the only change in Table 1 is the tabulation of five additional rows in the "Basic Table." Therefore, the greater the number of branches in a system, the greater is the extent of simplification in computations. When the three dimensional system reduces to its simplest form, i.e., a system of three pipe branches, rows (2), (7) and (12) may be left blank.

Since the locations of original X, Y and Z axes may be chosen "arbitrarily," it is best to select axes such that these axes, if extended, will pass through a maximum number of centroids of branches. Such a selection of axes decreases greatly the number of coordinates to be listed in Table 1, thereby cutting down the time and labor required for calculations. The author prefers the following selection: in a three-dimensional piping system, two of the axes are placed in a plane containing the greatest number of piping branches, while the third axis is colinear with a branch perpendicular to this plane. Such a selection is shown in Figure 1 as dotted lines and also in Example 1. In a single-plane system, the axes X and Y, if extended, pass through the individual centroids of at least two branches of the piping as shown in Figure 2. Such a selection is made in Example 3 for both single-plane and three-dimensional systems for comparison with Example 1.

Pipe Stresses

The moments and torques from Table 3 can be used to compute bending and torsional stresses at any point in a piping system. They are usually calculated for points of maximum bending moment and at the nozzles of vessels and equipment. The longitudinal stress f_l is the sum of bending stress f_b due to thermal expansion and axial stress f_p due to pressure inside the system. Hence,

$$f_l = f_b + f_p = \frac{M}{S} + p\left(\frac{A_i}{A_m}\right) \qquad (11)$$

where M = bending moment (in.-lb.)
S = section modulus (in.³)
p = internal pressure (psi)
A_i = cross-sectional area inside pipe (in.²)
A_m = cross-sectional metal area of pipe (in.²)

The torsional shear stress f_t is

$$f_t = \frac{T}{2S} \qquad (12)$$

where T = torque (in.-lb.)

The circumferential stress f_c is

$$f_c = 2f_p \text{ (approximate with sufficient accuracy)} \qquad (13)$$

The combined stress is then

$$f = \tfrac{1}{2}\left[f_l + f_c + \sqrt{4f_t^2 + (f_l - f_c)^2}\right] \qquad (14)$$

Right Palm Rule

This simple rule is used to determine quickly signs of moments and torques in Table 3. Assume the original arbitrarily chosen axes as shown below, their positive directions being opposite to the directions of thermal expansion Δx, Δy and Δz respectively. [See Eq. (4)]

Thus, the X-Y plane is parallel to paper, and the Z-axis is perpendicular to paper. The analyst should view X-Y plane by looking down at the paper, X-Z plane from top of paper and Y-Z plane from right side of paper. Then, open the right palm, and point the thumb in the direction of a force and the remaining fingers in the direction of centroidal distance of a point in the piping system (end or joint), i.e., the direction of coordinate $x - \bar{x}$, $y - \bar{y}$ or $z - \bar{z}$ in Table 3. If the palm is toward the analyst, the moment or torque is negative. If the back of the hand is toward the analyst, it is a positive value. For instance, in Example 1 for point a in X-Y plane, since the sign of $y - \bar{y}$ is negative (—8.19 ft.), point right thumb in the direction of X force and the remaining fingers in the direction of negative Y-axis. In this case, the palm of the right hand is toward the

BRANCH	X	Y	Z	l	lx	lx^2	ly	ly^2	lz	lz^2	lxy	lxz	lyz
ab	0	0	-7.3	15	0	0	0	0	-112.5	844	0	0	0
bc	0	+8	0	16	0	0	+128	1024	0	0	0	0	0
cd	+9	+16	0	18	+162	1458	+288	4608	0	0	+2592	0	0
de	+18	+10	0	12	+216	3888	+120	1200	0	0	+2160	0	0
	(1) BASIC SUM			61	+378	5346	+536	6832	-112.5	844	+4752	0	0
X-Y	(2) SUM OF BRANCHES PARA. TO Z-AXIS: ab												
	(3) = (2) × 0.3			4.5	0	0	0	0			0		
	(4) Σ = (1) + (3)			65.5	+378	5346	+536	6832			+4752		
	(5) SEE NOTES				$\bar{X}$ +5.77	Ⓐ +2180	$\bar{Y}$ +8.19	Ⓑ +4390			Ⓒ +3095		
	(6) = (4) − (5)					I'_x 3166		I'_y 2442			I_{xy} 1657		
X-Z	(7) SUM OF BRANCHES PARA. TO Y-AXIS: bc + cd			28	+216	3888			0	0		0	
	(8) = (7) × 0.3			8.4	+64.8	1166.4			0	0		0	
	(9) Σ = (1) + (8)			69.4	+442.8	6512.4			-112.5	844		0	
	(10) SEE NOTES				$\bar{X}$ +6.38	Ⓓ +2825			$\bar{Z}$ -1.622	Ⓔ +182.6		Ⓕ -7.18	
	(11) = (9) − (10)					I'_z 3687.4				I'_y 661.4		I_{xz} +7.18	
Y-Z	(12) SUM OF BRANCHES PARA. TO X-AXIS: cd												
	(13) = (12) × 0.3			5.4			+86.4	1382.4	0	0			0
	(14) Σ = (1) + (13)			66.4			+622.4	8214.4	-112.5	844			0
	(15) SEE NOTES						$\bar{Y}$ +9.375	Ⓖ +5840	$\bar{Z}$ -1.695	Ⓗ +190.7			Ⓚ -10.55
	(16) = (14) − (15)							I''_z 2374.4		I''_y 659.3			I_{yz} +10.55
(17) SEE NOTES						I_{xz} 767.3		I_{yz} 971		I_{xz} 766.9			
(18) $I'_x+I''_x+I_{xz}I_{xx}$ $I'_y+I''_y+I_{xz}I_{xy}$ $I'_z+I''_z+I_{xz}=I_{xz}$						I_x 4586.6		I_y 7032.8		I_z 3869.7			
(19) FROM (6), (11), (16)						I_{xy} 1657		I_{yz} 718			I_x 3869.7	I_{xy} 1657	I_{xz} 718
(20) Ⓟ (18)+(19) Ⓠ −(18)+(19) Ⓡ −(6)÷(19)						Ⓟ 2.77		Ⓣ 9.8			Ⓛ .428	Ⓜ .186	Ⓝ .697	Ⓢ 1.47
Ⓢ −(11)÷(19) Ⓣ −(16)+(19) Ⓤ −(16)÷(19)													

NOTES

$\bar{x} = \frac{\Sigma lx}{\Sigma l}$ Ⓐ,Ⓓ − $\bar{x}\Sigma lx$ Ⓔ − $\bar{z}\Sigma lx$ $\frac{\Sigma l_y^3}{12} = \frac{18^3}{12} = 486$

$\bar{y} = \frac{\Sigma ly}{\Sigma l}$ Ⓑ,Ⓖ − $\bar{y}\Sigma ly$ Ⓒ − $\bar{y}\Sigma lx$ $\frac{\Sigma l_x^3}{12} = \frac{16^3 + 12^3}{12} = 685$

$\bar{z} = \frac{\Sigma lz}{\Sigma l}$ Ⓔ,Ⓗ − $\bar{z}\Sigma lz$ Ⓚ − $\bar{z}\Sigma ly$ $\frac{\Sigma l_z^3}{12} = \frac{15^3}{12} = 281.3$

$I_{xz} = 685 + 281.3 = 766.3$

$I_{xy} = 486 + 281.3 = 767.3$

$I_{yz} = 486 + 485 = 971$

Ⓝ $= \frac{d_c I}{I_y} = \frac{18(874)160.8}{3869.7} = .654$

Ⓜ $= \frac{d_c I}{I_{xy}} = \frac{4(874)160.8}{1657} = .339$

Ⓛ $= \frac{d_c I}{I_{yz}} = \frac{15(874)160.8}{718} = 2.940$

TABLE 1—Moments and products of inertia for square-corner systems: Data for "Example 1" are inserted.

analyst so the moment $X(y - \bar{y})$ is a negative value (—8190). Using the same rule, the moment Y $(x - \bar{x})$ is a positive value (+3440). The total moment M_{xy} at point a is the algebraic sum of the two values or —4750 ft.-lb. When the force is a negative value, indicating its direction opposite to that assumed originally, the analyst should point the thumb in the same negative direction. This is illustrated by the X force (—658 lb.) in Table 3 of Example 3.

Although the positive direction of any one of the axes shown above may be reversed due to reversal of direction of expansion along that axis, it is convenient for the analyst to use the same notations for the axes, i.e., X and Y for axes in a plane parallel to paper.

EXAMPLE 1

A piping system with constant cross-sectional moment of inertia I = 160.8 in.⁴ (10 inch diameter, schedule 40) is shown in Figure 4. The analysis of this system is carried out in Tables 1, 2 and 3 in accordance with the procedure given above.

Carbon Steel
10 in. diam., sch. 40
I = 160.8 in.⁴
S = 29.9 in.³
A_i = 78.9 in.²
A_m = 11.91 in.²

T = 750° F.
c = 874
p = 420 psig

(1)		Ⓛ -.428	Ⓜ -.186	Ⓝ .654
(2)		Ⓟ 2.770	Ⓠ -.697	Ⓡ .339
(3)		Ⓢ -1.470	Ⓣ 9.800	Ⓤ 2.940
(4)	(1)+(2)	2.342	ⓐ -.823	993
(5)	(1)+(3)	-1.898	ⓑ 9.614	3.594
(6)	(5)×Ⓡ	ⓒ -.162	ⓐ .823	ⓓ 307.6
(7)	(4)+(6)	ⓔ 2.180		ⓕ 1300.6

$Y = \frac{ⓕ}{ⓔ} = \frac{1300.6}{2.18} = 597$ lb.

$Z = \frac{ⓓ + Ⓒ Y}{ⓐ} = \frac{307.6 + .162(597)}{.823} = 491$ lb.

$X = Ⓝ + ⓁY + ⓂZ$
$= 654 + .428(597) + .186(491)$
$= 1001$ lb.

TABLE 2—Forces.

Although the maximum moment in Table 3 occurs at "c," the second largest moment with a much greater torque occurs at "e," resulting in the maximum stress for the entire system. This is shown in the following calculations:

	POINT / COORD.	a	b	c	d	e			
	X	0	0	0	f 18	f 18			
	Y	0	0	f 16	f 16	f 16			
	Z	-15	0	0	0	0			
X-Y	PLANE	$\bar{X}$ = f 5.77			Y = 597				
	X-$\bar{X}$	-5.77	-5.77	-5.77	f 12.23	f 12.23			
(1)	MULT. Y	f 3440	f 3440	f 3440	-7300	-7300			
		$\bar{Y}$ = f 8.19			X = 1001				
	Y-$\bar{Y}$	-8.19	-8.19	f 7.81	f 7.81	-4.19			
(2)	MULT. X	-8190	-8190	f 7810	f 7810	-4190			
(1)+(2)	M_{xy}	-47.50	-47.50	f 11,250	f 510	-11,490			
X-Z	PLANE	$\bar{X}$ = 16.38			Z = 691				
	X-$\bar{X}$	-6.38	-6.38	-6.38	f 11.62	f 11.62			
(3)	MULT. Z	-3190	-3190	-3190	f 5710	f 5710			
		$\bar{Z}$ = -1.62			X = 1001				
	Z-$\bar{Z}$	-13.38	f 1.62	f 1.62	f 1.62	f 1.62			
(4)	MULT. X	f 13,380	-1,620	-1,620	-1,620	-1,620			
(3)+(4)	M_{xz}	f 10,250	-47.50	-47.50	f 4090	f 4090			
Y-Z	PLANE	$\bar{Y}$ = f 9.38			Z = 691				
	Y-$\bar{Y}$	-9.38	-9.38	f 6.62	f 6.62	-5.38			
(5)	MULT. Z	-4600	-4600	f 3250	f 3250	-2640			
		$\bar{Z}$ = -1.70			Y = 597				
	Z-$\bar{Z}$	-13.3	f 1.70	f 1.70	f 1.70	f 1.70			
(6)	MULT. Y	f 7950	-1017	-1017	-1017	-1017			
(5)+(6)	M_{yz}	f 3350	-56.17	f 2233	f 2233	-36.57			

MAX. $M = M_c = \sqrt{M_{xy}^2 + M_{xz}^2} = \sqrt{11,250^2 + 4,750^2}$ = 12,200 ft.-lb.

T_c = 2,233 ft.-lb. $M_e = \sqrt{11,490^2 + 5,657^2}$ = 12,030 ft.-lb. T_e = 4,090 ft.-lb.

TABLE 3—Moments and torques: Data for "Example 1" are inserted.

At "c"

$$f_l = \frac{12,200\ (12)}{29.90} + 420\left(\frac{78.9}{11.91}\right) = 4,900 + 2,782 = 7,682 \text{ psi}$$

$$f_c = 2\ (2,782) = 5,564 \text{ psi}$$

$$f_t = \frac{2,233\ (12)}{2\ (29.9)} = 448 \text{ psi}$$

$$f = \tfrac{1}{2}[7,682 + 5,564 + \sqrt{4\ (448)^2 + (7,682 - 5,564)^2}] = 7,772 \text{ psi}$$

At "e"

$$f_l = \frac{12,030\ (12)}{29.90} + 2,782 = 7,612 \text{ psi}$$

$$f_c = 2\ (2,782) = 5,564 \text{ psi}$$

$$f_t = \frac{4,090\ (12)}{2\ (29.9)} = 820 \text{ psi}$$

$$f = \tfrac{1}{2}[7,612 + 5,564 + \sqrt{4\ (820)^2 + (7,612 - 5,564)^2}] = 7,900 \text{ psi}$$

Simplification of Table 3

If only the maximum combined moment and its corresponding torque are required, then it is not necessary to obtain the true values of moments and torques at all points. In this case, their relative values may be used for comparison purposes, and the maximum relative values are chosen to calculate the true maximum combined moment. The calculations are accomplished in Table 3A. This table is especially convenient when the piping system consists of a large number of branches.

	POINT / COORD.								
	X								
	Y								
	Z								
X-Y	PLANE	$\bar{X}$ =		Y = Y/X =				$\bar{Y}$ =	
	X-$\bar{X}$								
(1)	MULT. Y'								
(2)	Y-$\bar{Y}$								
(1)+(2)	M_{xy}								
X-Z	PLANE	$\bar{X}$ =		Z' = Z/X =				$\bar{Z}$ =	
	X-$\bar{X}$								
(3)	MULT. Z'								
(4)	Z-$\bar{Z}$								
(3)+(4)	M_{xz}								
Y-Z	PLANE	$\bar{Y}$ =		Z' =					
	Y-$\bar{Y}$								
(5)	MULT. Z'								
		$\bar{Z}$ =		Y' =					
	Z-$\bar{Z}$								
(6)	MULT. Y'								
(5)+(6)	M_{yz}								

MAX. $M = M = X\sqrt{M^2 + M^2}$ =

T =

TABLE 3A—Moments and torques: For cases where only the maximum combined moment and its corresponding torque are required, this table will simplify the operation.

NOMENCLATURE

l, x, y, z = length and coordinates of the centroid of each piping branch or elbow (ft).

$\bar{x}, \bar{y}, \bar{z}$ = coordinates of the centroid of piping system (ft.)

I_x, I_y, I_z = moments of inertia of the system about its centroidal axes (ft.^{2})

I_{xy}, I_{xz}, I_{yz} = products of intertia of the system about its centroidal axes (ft.^{2})

l_x, l_y, l_z = lengths of piping branches parallel to X, Y and Z axes (ft.)

I_{ox}, I_{oy}, I_{oz} = sums of centroidal moments of inertia of the above lengths and elbows about their own respective neutral axes (ft.^{2}) [see Eq. (10) or Eq. (22)]

$I_{oxy}, I_{oxz}, I_{oyz}$ = sums of centroidal products of inertia of elbows. (ft.^{2}) [see Eq. (21)]

d_x, d_y, d_z = net lengths of the system expanding in X, Y and Z directions respectively (ft.)

I = cross-sectional moment of inertia of the pipe (in.^{4})

S = section modulus of pipe (in.^{3})

D = outside diameter of pipe (in.)

t = thickness of pipe wall (in.)

A_i = inside area of pipe (in.^{2})

Am = cross-sectional metal area of pipe (in.^{2})

T = temperature (° F)

p = pressure inside pipe (psig)

R = radius of curvature of elbow (ft.)

c = expansion factor (see "Piping Stress Calculations Simplified," by S. W. Spielvogel, P. 93)

ω = flexibility modification factor [see Eq. (18) and Figure 7]

λ = characteristics factor [see Eq. (19)]

X, Y, Z = forces due to expansion (lb.)

M_{xy}, M_{xz}, M_{yz} = bending moments due to X, Y and Z forces (one of these moments is actually a torque) (ft.-lb.)

(Parts 2 and 3 will appear in a coming issue.)

The Plan for Japan in Petrochemicals

They have a five-year plan and the Japanese government is making attractive tax concessions to local firms to get on the petrochemical bandwagon.

Igor Oganesoff,
Meguro-ku, Tokyo

JAPAN'S PETROCHEMICAL industry will soon begin production under a five-year (1955-1959) plan drafted by the government in cooperation with petroleum and chemical industrialists. It is expected that by 1959, domestic demand for 196,030 tons of various chemicals will be met entirely from domestic production.

The Japanese government is giving the program wholehearted support since it will reduce and ultimately eliminate the nation's dependence on foreign sources to satisfy its growing demand for petrochemical products. As seen in Figure 1, demand for products in the ethylene group has grown from 3560 tons in 1953 to an estimated 7360 tons in 1955. In the propylene group, consumption of 6320

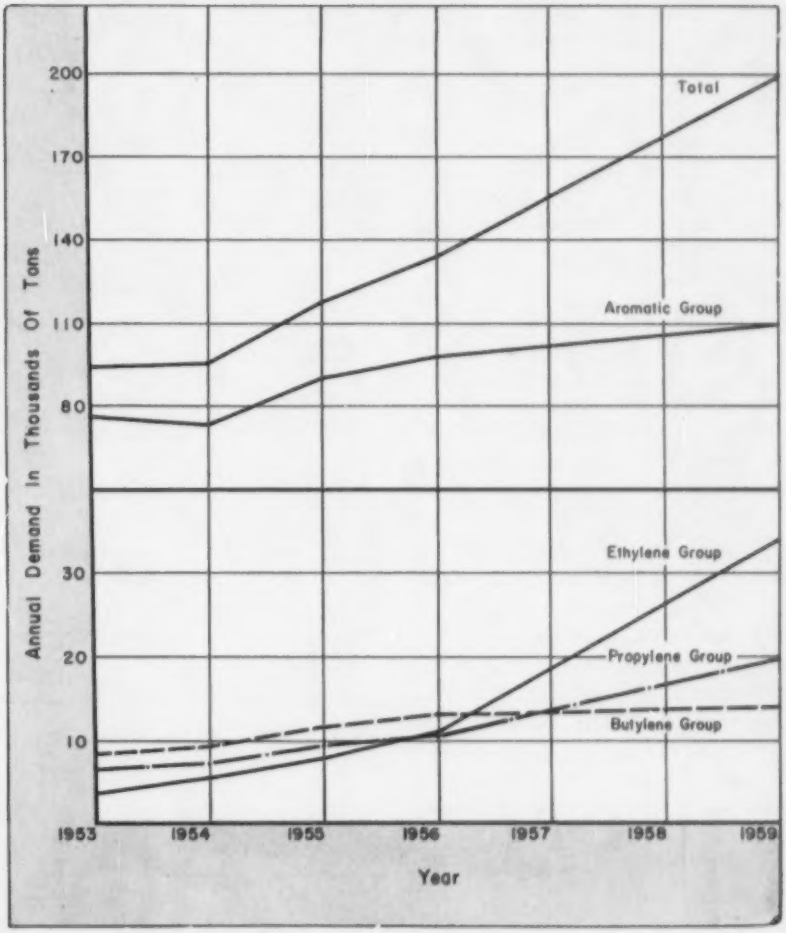


FIGURE 1—Demand for Petrochemical Products in Japan, 1953-59.

	1953	1954	1955	1956	1959
Ethylene	3,564	5,450	7,630	10,770	31,860
Propylene	6,325	7,110	9,120	10,390	19,780
Butylene	8,100	9,370	11,330	12,590	14,770
Aromatic	76,081	73,811	88,844	98,425	129,960
Total	94,070	95,741	116,924	132,175	196,370

Source: Ministry of International Trade and Industry, Japan National Committee, World Petroleum Congress.

tons in 1953 will rise to 9120 in 1955. Butylene demand is increasing from 8100 tons to 11,330 tons and requirements for petrochemicals in the aromatic group will expand from 76,080 tons in 1953 to 88,840 tons in 1955. By 1959, consumption of ethylene products will rise to 31,860 tons, propylene to 19,780 tons, butylene to 14,770 tons, and aromatic chemicals to 129,960 tons. Table 1 indicates the projected demand to 1959 for each product together with its uses.

The five-year plan is based on certain demand assumptions. For production of synthetic textiles it is estimated that, in 1959, a daily output of 47 tons of polyamide materials, 10 tons of polyester materials and 78 tons of acetate fibers will be needed. Demand for synthetic resins will require annually 14,000 tons of polyethylene, 10,000 tons of polystyrene, 3000 tons of polyester resins, 14,200 tons of phenol resin, and 2500 tons of methacrylate. Enough paint solvent made from petrochemicals for 133,000 tons of ordinary paint and 29,000 tons of synthetic paint per year will also be required by 1959. Approximately 50 percent of the estimated 11,000 tons of alcohol for chemical industry use will be derived from petrochemicals in 1959.

Part of the demand will continue to be met by the fermentation industry, which will produce a minimum of 5800 tons of butanol and 2700 tons of acetone annually (see Table 2). However, acetone and butanol will no longer be produced from carbide. There will be only a slight increase in manufacture of aromatic chemicals from the by-products of coal distillation.

The only petrochemicals now being produced domestically are methanol (1000 tons monthly) and formaldehyde (600 tons monthly).

The five-year plan has three major objectives:

1. The new industry will supply benzene, phenol and acetone to the nylon and acetate industries, and will produce methacrilate resin and phenol resin.

2. Ethylene products which are now imported and for which demand is rising sharply will be produced domestically.

TABLE 1

Demand Growth for Petrochemicals for Various Products in Japan (1954-1959)

Source: Ministry of International Trade and Industry

PRODUCT	Uses	DEMAND IN TONS PER YEAR 1954	1955	1956	1959
Ethylene					
Ethylene Oxide	Surface activator	800	1,250	1,500	2,060
Ethylene glycol	Dynamite	300	300	300	350
	Cosmetics	210	240	260	350
	Anti-freeze and Cellophane	650	700	750	900
	Synthetic Textiles (Dacron, etc.)	.....	.....	.....	1,200
Di-ethylene & triethylene glycol	Polyester	50	160	400	1,200
	Cellophane and others	300	330	350	450
Polyethylene glycol	Surface activator	300	500	590	810
	Others	100	120	120	150
Ethylene-glycol-ether	Paint	715	900	1,020	1,140
Polyethylene	Synthetic resin	2,000	3,000	5,000	14,000
Styrene monomer	Polystyrene	.....	.....	3,150	10,500
	Polyester	25	100	250	750
	Ion exchange resins	.....	30	40	60
Propylene					
Isopropynol	Disinfectants	50	150	200	350
	Solvents	400	1,100	1,650	5,500
Acetone	Acetate textiles	590	880	1,140	3,800
	Solvents	550	600	630	750
	Methacrilate resin	820	1,360	1,560	3,250
	Photographic materials	420	320	210	0
	Medicine	920	1,050	1,200	1,600
	Paint	290	320	350	450
	Others	470	480	580	500
	Export	200	.....	.....	.....
Methyl isobutyl ketone & di-iso-butyl ketone	Paint	1,870	2,050	2,220	2,730
Propylene glycol	Cosmetics	530	610	650	850
Butylene					
Methyl ethyl ketone	Oil Refining	570	400	400	400
	Others	170	200	220	250
Butanol	Butylacetate	1,680	1,680	1,680	1,400
	Octanol	1,400	1,560	1,560	1,560
	Di-butyl phthalate	1,800	2,100	3,000	3,960
	Other plasticizers	250	350	450	600
	Paint	2,400	2,640	2,880	3,600
	Others	600	600	600	600
	Export	500	1,800	1,800	2,400
Aromatic					
Xylenes	Paint	2,803	3,310	3,500	3,960
	Textiles (paraxylol)	60	40	.....	2,340
	Others	450	550	600	700
Solvent benzene	Paint	13,672	13,730	14,700	15,000
	Others	3,935	4,000	4,200	5,000
Solvent naphtha	Paint	3,641	4,136	4,380	4,830
	Dyestuffs	530	625	630	740
	Fuel	1,337	1,280	1,300	1,400
	Others	500	520	550	640
Synthetic phenol	Textiles	6,209	11,080	12,000	17,200
	Synthetic resin	1,185	1,320	1,490	1,700
	Others	1,309	1,696	1,965	2,450
Benzol	Carbonic acid	8,335	14,147	15,500	21,500
	Textiles	.....	.....	2,600	2,600
	Styrene monomer	.....	.....	2,640	8,800
	Dyestuffs	12,037	14,050	14,470	16,910
	Insecticide	4,201	4,220	4,400	5,300
	Paint	1,600	1,740	1,800	1,490
	Export	522	.....	.....	.....
	Other	3,600	3,600	3,800	4,400
Toluene	Dyestuffs	3,003	3,450	3,450	4,030
	Textiles	102	150	50	.....
	Paint	1,384	2,000	2,170	4,280
	Others	661	700	730	850
	Dynamite	2,735	2,500	2,500	3,840

3. The domestic industry will sell major industrial materials like acetone, phenol, and benzol in Japan at lower than import prices.

Meet the Author

IGOR OGANESOFF is a freelance journalist in Tokyo. A New York University and Columbia University graduate, he worked for the Department of the Army as an economic and political analyst in Washington, Germany and Japan before taking up writing as a full-time job three years ago. He returned to Japan three years ago to report on trade and industry in the Far East.

To give impetus to this program, the Ministry of International Trade and Industry (MITI) is prepared to offer tempting concessions to selected firms entering the field. These include long term loans from the Japan Development Bank and a three-year exemption from the normal 42% corporate tax on profits from production of petrochemicals. In addition, the government will permit Japanese firms to conclude technical aid agreements with foreign companies and will guarantee remittance of royalties in dollars or pounds sterling. Should foreign loans be required, similar guarantees will be granted for repatriation of principal and interest in the currency of the lender. Finally, MITI will allocate foreign exchange for the purchase of needed machinery and equipment from abroad (about $800,000

this year) and will reduce or eliminate duties on such imports.

Imports of crude and refined petroleum will not be increased for the production of petrochemicals; rather a portion of the present supply (1-2 percent) will be diverted from other uses to make petrochemicals. While the government is anxious to get full-scale production under way as soon as possible, it is also concerned about the impact of petrochemical production on already-existing fermentation industries producing tar, alcohol, and similar products; hence the expansion will be gradual.

Who Will Make These Petrochemicals?—Six companies now have concrete plans to produce petrochemicals. Others will no doubt enter the field but Mitsubishi Oil Company, Nippon Petrochemical, Maruzen Oil, Mitsui Petrochemical, Shell-Mitsubishi Petrochemical, and Sumitomo Chemical Industries will be the backbone of the new industry, with a total production capacity of 196,700 tons annually.

► **Mitsubishi Oil Company** (50 percent owned by Tide Water Associated Oil Company) will begin construction of a $3,520,000 plant in October 1955 which will supply 4000 tons of benzol, 3000 tons of toluene, and 3000 tons of xylene annually upon completion in 1956. Two units will be contained in the plant; a platforming apparatus to convert naphtha to light gasoline, with a daily capacity of 3000 barrels, and a Udex extraction plant with a production capacity of 750 barrels per day to extract benzol, toluene, and xylene from the gasoline. The Udex extractor will cost about $1,470,000 and the platforming apparatus about $1,960,000. Equipment for both units will be *imported*.

► **Maruzen Oil Company** is planning to produce 2400 tons of secondary butyl alcohol, 1800 tons of methyl ethyl ketone and 2400 tons of isopropyl alcohol annually. They will finish construction of a $1,610,000 plant early next summer with $1,150,000 of the investment to be put into the facilities for producing methyl ethyl ketone and secondary butyl alcohol, and the remainder for manufacturing isopropyl alcohol.

Using a fluid catalytic cracker to produce gasoline from light oil, Maruzen will separate the residue gases to produce petrochemicals. The propylene gas will be used to produce isopropyl alcohol. Butylene gas will go to secondary butanol and methyl ethyl ketone.

TABLE 2

Demand Supply Estimate for Petrochemicals in Japan

Source: Ministry of International Trade and Industry

	1954			1959		
	Total Demand	Production in Fermentation & Other Industry	Imports	Total Demand	Production in Fermentation & Other Industry	Production Petrochem. Industry
Ethylene						
Ethylene oxide	800	780	20	2,060	.....	2,060
Ethylene glycol	1,160	.....	1,160	2,800	.....	2,800
Diethylene & triethylene glycol	350	.....	350	1,650	.....	1,650
Polyethylene glycol	400	.....	400	960	.....	960
Ethylene-glycol-ether	715	.....	715	1,140	.....	1,140
Polyethylene	2,000	.....	2,000	14,000	.....	14,000
Styrene monomer	25	.....	25	11,310	.....	11,310
Propylene						
Isopropyl alcohol	450	.....	450	5,850	.....	5,850
Acetone	4,260	4,000	260	10,350	2,700	7,650
Methyl-Isobutyl-ketone & di-iso-butyl-ketone	1,870	.....	1,870	2,730	.....	2,730
Propylene-glycol	530	.....	530	850	.....	850
Butylene						
Methyl-ethyl-ketone	740	.....	740	650	.....	650
Butanol	8,630	9,380	.....	10,550 to 14,120	5,800	4,750 to 8,320
Aromatic						
Benzene	30,295	33,330	.....	61,000	43,600	17,400
Toulene	7,885	6,340	1,545	13,000	6,750	6,250
Xylenes	3,313	1,190	2,123	7,000	1,450	5,550
Solvent benzene	17,607	19,290	.....	20,000	16,000	4,000
Solvent naphtha	6,008	5,460	648	7,610	7,610	0
Synthetic phenol	8,703	8,310	393	21,350	14,350	7,000

► **Nippon Petrochemical Company** will be established as a subsidiary of Nippon Petroleum Company (which joined California Texas Corp. in setting up a 50-50 subsidiary, Nippon Petroleum Refining Co., in 1951). The new petrochemical firm will produce 3500 tons of acetone and 2000 tons of isopropyl alcohol annually, starting in October 1956, with an investment of $2,220,000 in plant equipment. Approximately one year later, it will also begin manufacturing methyl isobutyl ketone at the rate of 2200 tons per year.

Like Maruzen, Nippon Petrochemical Company will utilize a fluid catalytic cracker and gas separator to obtain propylene gas for isopropyl alcohol and acetone. Methyl isobutyl ketone will later be produced from di-acetone.

► **Mitsui Petrochemical Company's** plan is most ambitious of all. The new firm was formed jointly by seven industrial companies; Mitsui Mining, Mitsui Chemical, Toyo Koatsu, Mitsui Metal Mining, Miike Gosei, Toyo Rayon, and Koa Oil Company (50 percent owned by Caltex Oil Products Company) plus the Mitsui Bank. Mitsui's project is divided into two stages, each taking two years. The first, for which construction is scheduled to start late this year, aims at an annual production of 3600 tons of polyethylene, 1300 tons of ethylene oxide, 7400 tons of phenol, 4400 tons of acetone, 3400 tons of benzene, 16,800 tons of toluene and xylene, and 6000 tons of propane. Total investment required to complete the first phase will be about $12,850,000.

The second two-year project scheduled for completion in late 1959 at an additional cost of $11,885,000, visualizes boosting polyethylene capacity to 7800 tons, and benzene to 5600 tons. Toluene and xylene production will be cut to 15,100, but the difference will be made up by new production of 1600 tons of paraxylene annually. Production of ethylene glycol (2400 tons), dimethyl terephthalate (6200 tons), ammonium sulphate (36,000 tons) and urea (36,000 tons) will also be added by the end of 1959. Production capacity for phenol, acetone, ethylene oxide, and propane will remain the same during the second half of the program.

Mitsui is planning to produce benzene, toluene, and xylene using a platforming apparatus and a Udex extractor. A gas cracking unit will be used to manufacture ethylene, from which polyethylene, ethylene oxide, and ethylene glycol will be obtained, and propylene, to produce acetone and phenol.

► **Sumitomo Chemical Industry** has decided to make 5000 tons of polyethylene annually. Other details of this project are not yet available, and the target date for commencing production is uncertain.

The fuel injection pump, heart of the fuel injection system, sends a metered amount of fuel at timed intervals through the fuel lines shown here into each of the combustion chambers.

Engine System of the Future?

FUEL INJECTION passenger cars were previewed recently at Atlantic City, N. J., in a Lincoln fuel test car equipped by the E. I. du Pont de Nemours & Company. The fuel system installed in the Lincoln by Du Pont automotive engineers is one of the first systems of its kind to be used in a passenger car. This system, which may soon be offered in some of the higher priced automobiles, provides metered and identical amounts of fuels to each of the cylinders at timed intervals.

Among the advantages of the system as shown in Du Pont tests, are the lowering of octane requirements of the engine and the fact that fuels with higher volatility and higher end point may be used. At the same time, vapor locking tendencies are decreased, permitting the use of higher volatility fuels. From the standpoint of styling, elimination of the carburetor will enable designers to lower hoodlines.

Provided by Du Pont to show refiners some long-term effects this new fuel distribution method may have on the refining industry, this automobile has been used by the company to gather data during the past several months. These data have been correlated by Du Pont's refinery technologists to show how certain fractions from the crude may be upgraded to raise both end point and volatility and to provide increased profits.

The Du Pont tests on the company's modern chassis dynamometer at the Petroleum laboratory at Deepwater Point, N. J., proved most of the other claims which have been made for fuel injection. They demonstrated, for instance, that fuel injection could result in lowering the octane requirement of an engine by as many as five numbers. This lower octane demand results from the engine running cooler.

The relative freedom from vapor lock was demonstrated by using a critical vapor lock procedure on the chassis dynamometer. This test included high speed driving followed by a "heat soak" period and it was found that a fuel injection engine can tolerate a Reid vapor pressure fuel at least five pounds higher than a carbureted engine.

The mechanical components of this new fuel system consist of a pump to transfer fuel from the pressurized tank at about 35-pounds per square inch through a filter to the fuel injection metering pump. The injection pump then distributes the required amount of fuel to each of the eight fuel nozzles in the intake ports where the fuel is sprayed into the air stream.

##

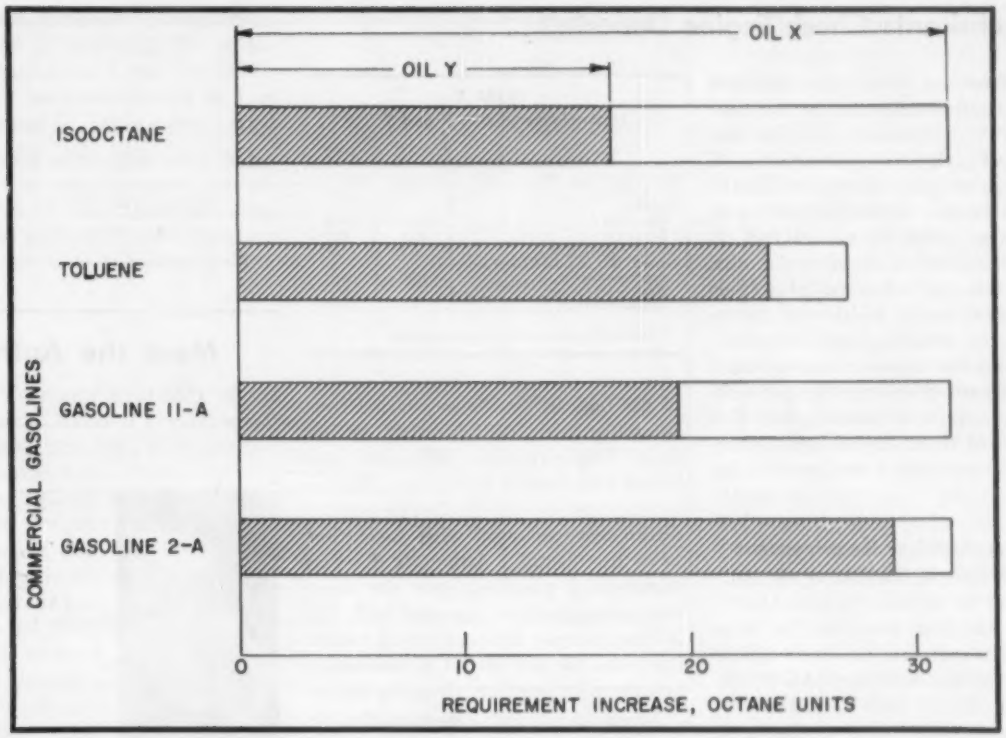


FIGURE 1—Effect of oil type on requirement increase with several fuels.

Can Lubricants Check Engine Deposits?

An evaluation of the effect of different type lubricants on combustion chamber deposits and the resultant octane number requirements.

C. A. Hall,
Ethyl Corporation,
Detroit

COMBUSTION-CHAMBER deposits are responsible for two undesirable effects which hinder the utilization of higher engine compression ratios for increased engine efficiency. One of these deposit effects is a tendency to increase the fuel octane number required for the suppression of ordinary knock. The other effect is surface ignition—the tendency of the deposits to ignite the fuel-air mixture erratically, thereby producing uncontrolled combustion. Surface ignition may result in an increased knocking noise, audible to the motorist, and/or in engine roughness. It is now a widely-accepted fact that the lubricating oil, as well as the fuel, contributes to the formation and effects of combustion-chamber deposits.

The role played by lubricating oil in deposit formation was investigated as early as 1925, when Orelup and Lee[1] studied the formation of carbonaceous engine deposits and attempted to correlate them with the consumption of lubricating oil and with the type of oil used. In 1931, Bahlke[2] and co-workers studied the effects of lubricating-oil factors, and concluded that carbon formation was related to the volatility of the oil. Two years later, Gruse[3] pointed out that deposit formation is influenced by oil characteristics. Recognizing that oil volatility was the factor which affected coking of the oil, he also pointed out that the nonvolatile fractions of the oil tend to form the more-adherent carbonaceous deposits through coking distillation.

Most of the early published information on the effect of lubricating oils was concerned primarily with the weight of deposits formed. Furthermore, these earlier investigators were not particularly concerned with fuel additives (such as TEL) and with oil additives as important factors in de-

posit formation, since such additives were not universally used at the time of their investigations. In the late 1940's and early 1950's, however, both the petroleum and automotive industries have made substantial efforts to learn more about the causes and effects of combustion-chamber deposits, and the role that lubricants play. This more recent work, which was stimulated by the trend to higher compression ratios in engines, has revealed that lubricant characteristics not only influence deposit formation, but also the effect of these deposits on octane-number requirement and surface ignition.

Octane-Number Requirement

The relation of lubricating oil characteristics to octane-requirement increase has been evaluated by comparing the effects of two typical commercial, non-additive, SAE 20 oils. The two oils, X and Y, had widely different characteristics as shown in Table 1.

In controlled road tests, Oil Y caused a smaller octane-requirement increase than did Oil X. These two oils were then tested in a laboratory single-cylinder engine with different fuels and the results are shown in Figure 1.

The large increases in octane requirement obtained in these single-cylinder engine tests are due to the low initial requirement of the engine and to the use of a retarded spark. However, the test results do correlate with road-test results. The differences in requirement increase between the two oils, shown by the open portions of the bars in this figure, varied considerably with the different leaded fuels. The greatest difference was found with leaded iso-octane, which is a clean burning paraffin, while smaller differences occurred with fuels that burn less cleanly. Although the two commercial gasolines gave the same octane-requirement increase with Oil X, the decrease in requirement resulting from the use of Oil Y was much greater with one fuel than the other.

TABLE 1
Analyses of Oils X and Y

	Oil X	Oil Y
Distillation Range, F°	316-419+	266-356+
Gravity, °API	29.5	20.0
Viscosity:		
Sus at 100 F	307.0	475.0
Sus at 210 F	53.4	52.2
Sulfur, Weight Percent	0.28	0.26
Percent (Wt.) of Total Carbon as:		
Paraffinic Carbon	55	40
Naphthenic Carbon	27	41
Aromatic Carbon	8	19

* At 0.080 to 0.140 mm Hg absolute pressure.

From these and other studies, it may be reasoned that both fuels and oils decompose in the combustion chamber and furnish resinous, organic materials. These materials, which act as binders, tend to hold other deposit materials, including lead compounds, in the combustion chamber. The observed differences in requirement increase between oils will be most noticeable if clean-burning fuels, which produce very little resinous binder, are used for tests. On the other hand, if the fuel produces considerable organic residue, then the differences between oils will be much less. These data emphasize the importance of fuel selection when investigating the effects of lubricating oil. In studying the deposit-forming characteristics of lubricating oil, therefore, it is often desirable to use a clean-burning fuel, such as leaded isooctane, in order to better evaluate the oil factors.

Oil Volatility—The previous data showed that the two reference oils were different in deposit-forming characteristics. Since these oils differed in both hydrocarbon composition and

Meet the Author

C. A. HALL, a supervisor at Ethyl Corporation's research laboratories in Detroit, Mich., first discussed this subject before a local AIChE section meeting in Galveston, Texas. Prior to joining the Ethyl organization in 1942, he was an instructor in the Mechanical Engineering department at Rice Institute and previously had been associated with General Motors Corporation's Frigidaire Division. Hall, a mechanical engineering graduate from Ohio State University, holds a master's degree from the University of Michigan and received a professional degree as mechanical engineer from Ohio State. At the laboratories in Detroit, he is responsible for supervising research in automotive fuels and lubricants.

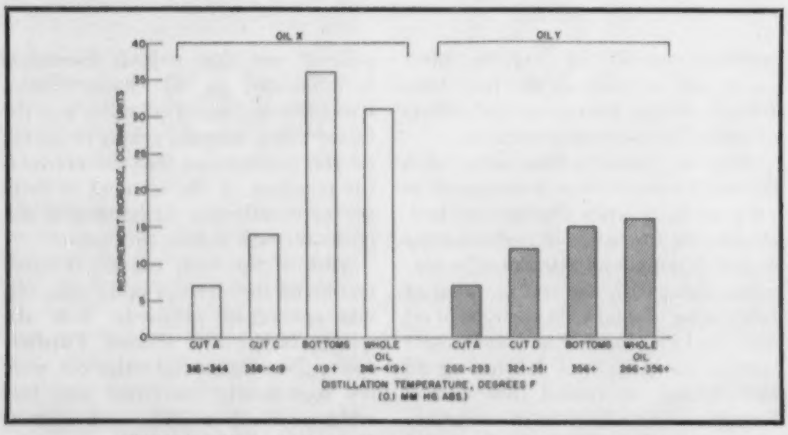


FIGURE 2—Effect of oil volatility and type on requirement increase.

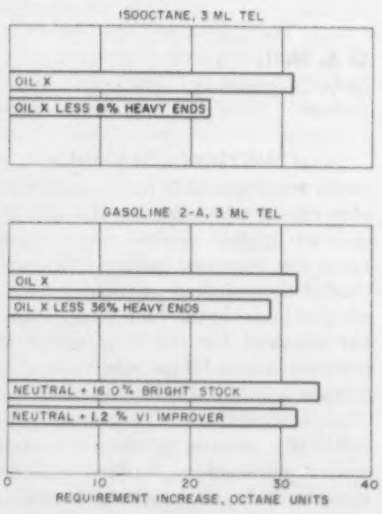


FIGURE 3—Effect of high boiling constituents of oil on requirement increase.

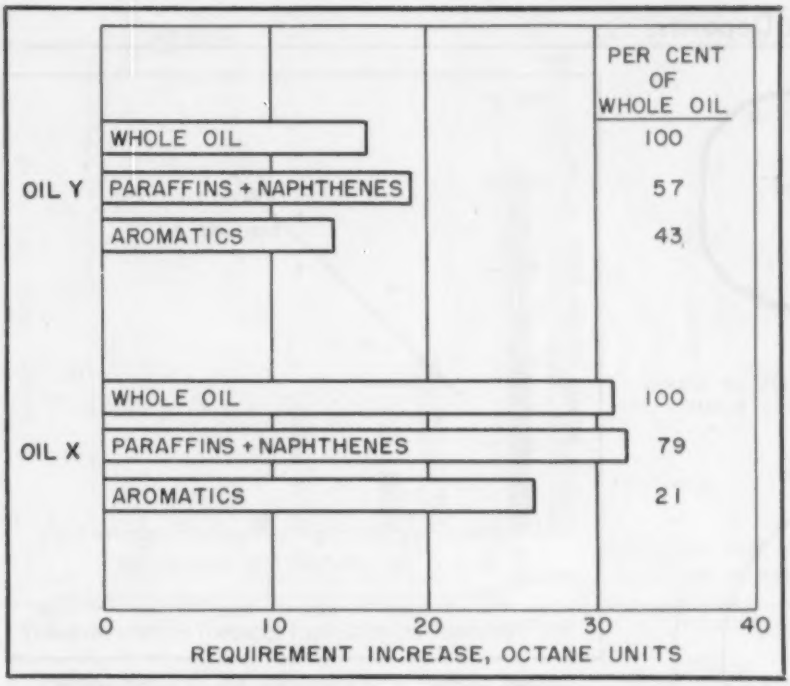


FIGURE 4—Effect of chemical components of oils on requirement increase.

volatility, these factors were investigated separately to determine their individual effect on octane-requirement increase.

To study volatility, both oils were separated by vacuum distillation into cuts of various boiling ranges. These cuts were then tested in a single-cylinder engine, using leaded isooctane as the fuel. The results are shown in Figure 2.

The low-boiling cuts of both oils gave low octane-requirement increase, while the higher boiling cuts gave progressively greater deposit effects; the undistilled bottoms producing the largest increases in octane requirement. The octane-requirement increase was particularly large with the high-boiling bottoms of Oil X, which were worse than the whole oil in this respect. It can also be observed that Oil Y (whole oil) had a lower boiling range and gave a smaller octane requirement increase than Oil X (whole oil).

Since the cuts from each oil were all quite similar in composition as measured by hydrocarbon type proportions, it appears that the variations in the octane-requirement increases caused by these distilled cuts are primarily due to differences in volatility. The results with the highly-volatile oil cuts emphasize the fact that a low level of octane-requirement increase can be obtained with a clean-burning leaded fuel and a volatile oil.

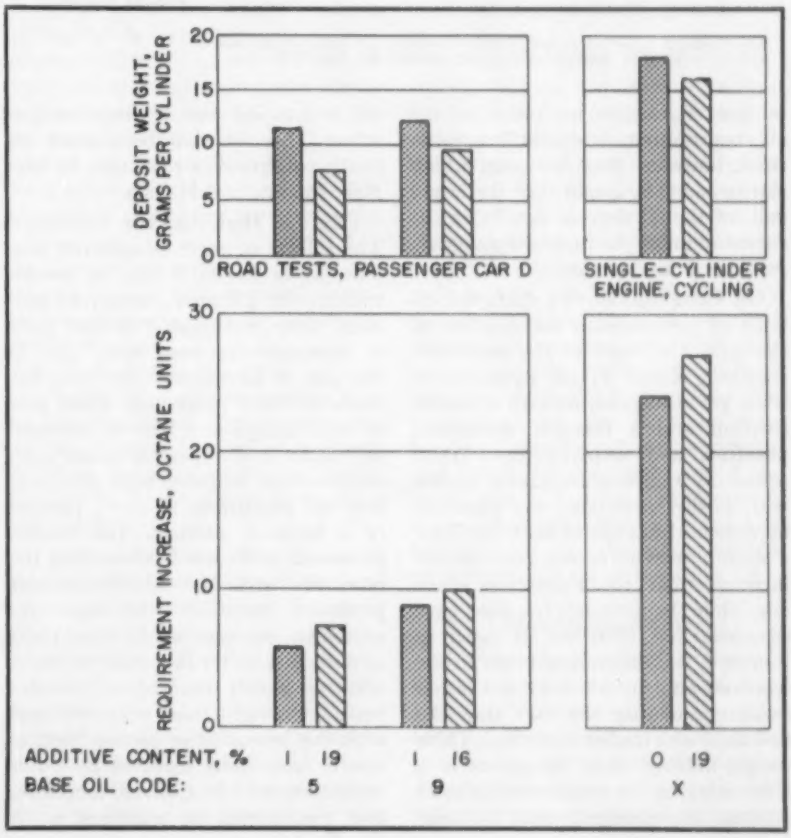
Additional tests were made with only the heavy ends of Oil X removed by vacuum distillation. As shown in the upper portion of Figure 3, removal of the heaviest 8 percent of the oil reduced the requirement increase by 30 percent when leaded isooctane was used as the fuel.

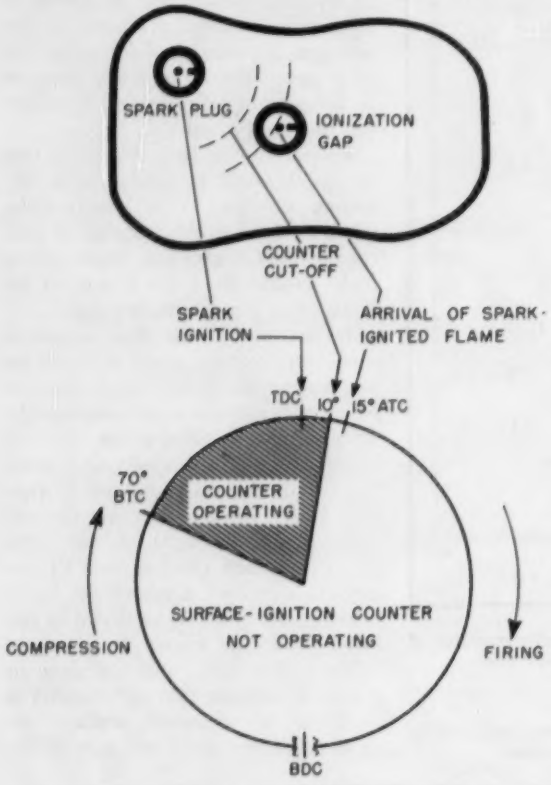
Previous work had suggested that the gains would be smaller with full-boiling gasoline. This was verified when removal of the heaviest 36 percent of the oil gave less improvement with gasoline than the 8 percent removal had given with isooctane.

It was also found that a similar small improvement could be made by eliminating the bright stock from a blend of bright stock and neutral oils. In making this comparison, two oil blends of the same viscosity were used. One of the blends contained 16 percent bright stock to increase the viscosity of light, neutral oil; the other blend contained a commercial VI improver, and gave a somewhat lower requirement increase, as shown in the lower portion of Figure 3.

These test data, and the data in Figure 2, indicate that oil volatility is a factor in octane-requirement increase, and that the heavy ends of the

FIGURE 5—Effect of oil additive concentration on requirement increase.





ANY SURFACE-IGNITED FLAME FRONT ARRIVING AT IONIZATION GAP BETWEEN 70° BTC AND 10° ATC IS RECORDED BY COUNTER.

FIGURE 6—Portion of engine cycle during which surface ignited flame fronts are recorded.

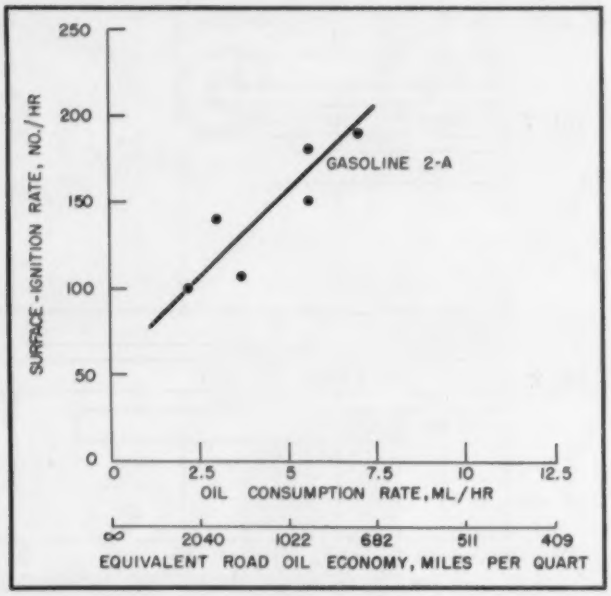


FIGURE 7—Effect of oil consumption rate on surface ignition.

oil are responsible for much of the oil's contribution. It should be emphasized, however, that the gains which can be made by removal of the heavy ends of the oil depend largely on the contribution of the fuel to the organic portion of the deposits.

Oil Composition—To study the effects of hydrocarbon composition of the lubricants, each of the two reference oils, X and Y, was separated by silica gel adsorption into an aromatic fraction and a fraction containing paraffins and naphthenes. When tested in the single-cylinder engine with leaded isooctane, the paraffin-naphthene fractions of both oils gave a slightly greater octane-requirement increase than the respective whole oils, while the aromatic fractions gave somewhat less. However, as shown in Figure 4, the differences between the fractions and the whole oil are rather small considering the fact that the fuel used was leaded isooctane. These results indicate that the effects of a lubricating oil on octane-requirement increase are governed more by volatility than by hydrocarbon composition. This fact has been more recently confirmed in road tests by McNab, Moody, and Hakala.[4]

Effect of High-Additive Content—The effects of high oil-additive content, as in Series 2 oils, in combination with a leaded commercial gasoline were investigated in two pairs of passenger-car road tests, and in one pair of laboratory tests using the single-cylinder procedure. Each pair of tests compared a base oil containing either 0 or 1 percent of an antioxidant-type additive with the same base oil containing 16 or 19 percent of a Series 2 additive. The results, presented in Figure 5, show that the base oils and high-additive blends produced essentially the same requirement increase in all three pairs of tests, despite the fact that the high-additive blends resulted in less deposits by weight than were obtained with the low-additive blends. Similar results have been reported by other investigators.[5,6] It appears, therefore, that commercial oil additives, when used in conventional oils and in combination with present-day motor fuels, are not a major factor in the octane-requirement-increase problem.

Surface Ignition

In addition to raising the octane requirements for suppression of ordinary knock, combustion chamber deposits also tend to ignite the fuel-air mixture erratically, a phenomenon called surface ignition or deposit ignition. Ignition of the fuel-air mixture by deposits produces uncontrolled combustion noticeable as autoignition, wild ping, preignition, and engine roughness.

Early studies of surface ignition, caused by deposits, revealed the need for special instrumentation. The conventional method for rating surface ignition was an audible one, in which the ignition key was turned off when knocking noises were heard. If the engine continued to run, it was evident that deposits or other engine hot spots were igniting the fuel-air mixture. Since the phenomenon was

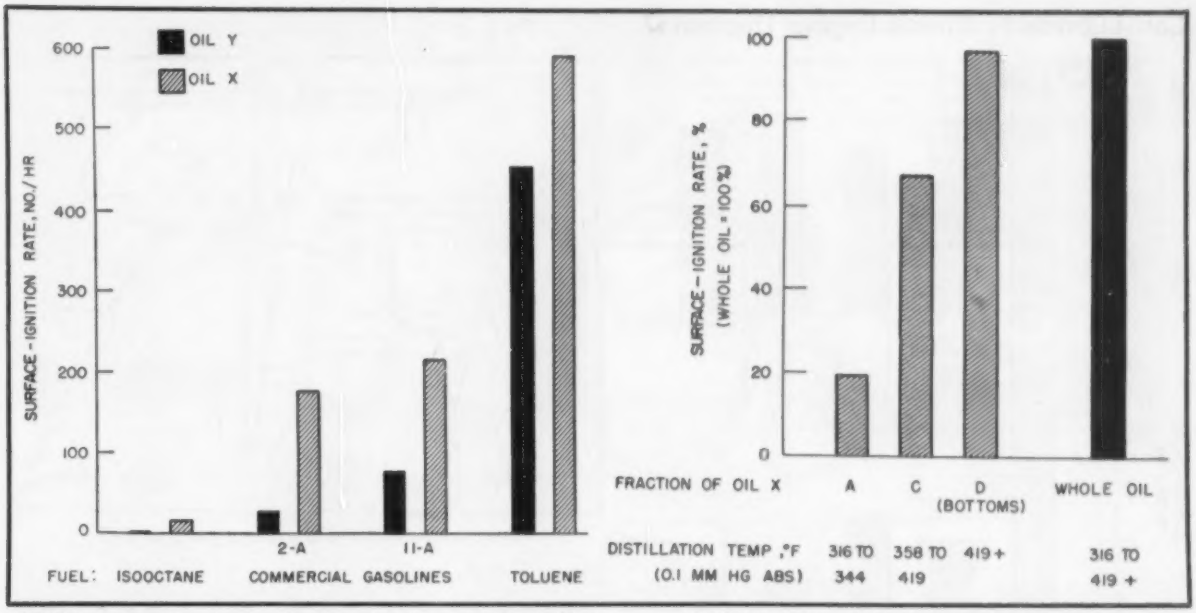


FIGURE 8—Comparison of surface ignition rates of two oils tested with four fuels.

FIGURE 9—Effect of oil volatility on surface ignition.

a very erratic one, instrumentation was required which would detect and record the number of times the deposits actually ignited the fuel-air mixture.

To fill this need, a surface-ignition counter for a single-cylinder engine was developed in the Ethyl laboratories. This counter automatically detects and counts uncontrolled combustion arising from ignition by the deposits, and differentiates it from normal combustion. Its basic components consist of an electronic circuit, an electro-mechanical recording counter, a camshaft driven timing device, and an ionization gap in the combustion chamber. Differentiation between normal and uncontrolled combustion is accomplished by having the counter operate only during a selected portion of the engine cycle before the normal spark-ignited flame front arrives at the ionization gap.

Figure 6 shows the relative location of the spark plug and ionization gap, and the portion of the engine cycle in which surface ignition is recorded. The engine's operating conditions are controlled so that the spark-ignited flame front arrives at the ionization gap at about 15 degrees after top center. Since the counter records only those flame fronts which arrive at the ionization gap from 70 degrees before top center to 10 degrees after top center, it provides an accurate record of deposit-induced ignition (surface ignition).

With this equipment, a gasoline-lubricating oil combination can be run in the engine, and the number of times the deposits ignite the fuel-air mixture can be recorded over a long period of time. Thus, various gasoline-lubricant combinations can be compared as to their ability to form the type of deposits that cause surface ignition. It should be noted that this procedure and instrumentation measures both the combined effect of the gasoline-oil combination to form the type of deposits which tend to ignite the charge and the ease with which the fuel is ignited by these deposits.

More recently a multicylinder-surface-ignition counter has been developed for use with modern passenger car engines both in the laboratory and on the road.[7]

In investigating oil effects, it was found that the surface-ignition rate increased as the oil consumption rate became greater. This effect is shown in Figure 7, which covers the results obtained with a commercial gasoline and Oil X.

The two reference oils, X and Y, used in the octane-requirement-increase study were tested for their effects on surface-ignition rate. As shown in Figure 8, Oil Y consistently produced a lower surface-ignition rate than Oil X with each of four leaded fuels—isooctane, two commercial gasolines, and toluene. Isooctane produced the least amount of surface ignition; toluene produced the greatest amount; and the two commercial gasolines were intermediate. It appears, however, that the relative effect of the lubricants may be observed, regardless of the fuel used. These data showed that surface ignition was essentially eliminated when the Oil Y was used in combination with leaded isooctane.

In order to study the effect of oil volatility alone, Oil X was vacuum distilled into four fractions, and three of these fractions were tested with leaded isooctane for comparison with the whole oil. The data in Figure 9 are expressed as a percentage of the surface-ignition rate obtained with the whole oil, and show that surface-ignition rate was less with the more volatile fractions. These variations in surface-ignition rate are believed to be due primarily to the changes in oil volatility, since the hydrocarbon-type proportions of the fractions were quite uniform throughout the distillation range. Williams and Landis[8] also found that the surface-ignition tendencies were associated with the high boiling and not the more volatile components of the lubricating oil.

Multigraded Oils

A recent development in the field of lubricating oils has been the marketing of multigraded oils, so called because their high viscosity index permits the oils to meet the viscosity specifications of several different SAE grades. These new oils take advantage

Can Lubricants Check Engine Deposits? . . .

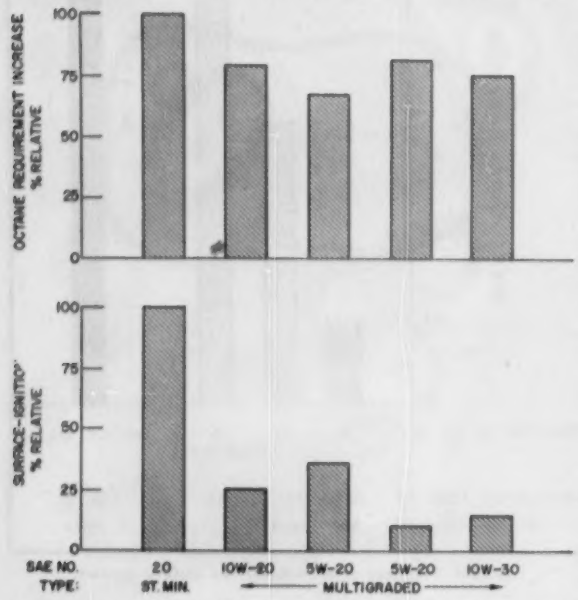


FIGURE 10—Effect of multigraded oils in single cyclinder engine test procedure.

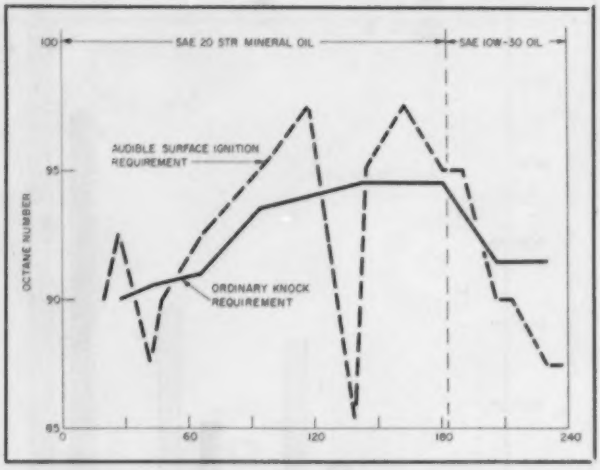


FIGURE 11—Effect of changing to a multigraded oil.

of the beneficial effect of increased oil volatility on both octane-requirement increase and surface ignition. Besides reducing the "noise" effects of deposits, these multigraded oils provide additional benefits to the motorist through easier cold weather starting and improved fuel economy. The latter benefit results from a reduction in friction losses, particularly during periods of engine warmup. These beneficial characteristics are achieved without sacrificing oil consumption properties.

The multigraded oils are made by blending distillate oils which boil within relatively narrow ranges. The high-boiling fractions, which increase deposit formation in conventional oils, and the low-boiling fractions, which promote high oil consumption, are eliminated. Viscosity index (VI) improvers are added to these low viscosity oils in order to raise their viscosity at engine operating temperatures. The high viscosity index of the final blend often permits the oil to meet the viscosity specifications of several different SAE grades. These new oils also contain large amounts of other additives, such as oxidation inhibitors and detergents which provide good engine cleanliness characteristics.

Recently, numerous technical papers have been published which document the effectiveness of these multigraded oils in lowering the ordinary knock and audible deposit-ignition effects of deposits, as compared with conventional motor oils. Figure 10 presents data obtained in the Ethyl laboratories using the single-cylinder engine procedure. The test results, which compare four different multigraded oils with a conventional SAE 20 straight-mineral oil, reveal substantial improvements when multigraded oils are used. As shown in the upper part of the chart, octane-requirement increase with multigraded oils is only about 75 percent as much as with the straight-mineral oil. The lower portion of the chart shows that these new oils reduce surface-ignition rate to only one-quarter of the rate produced with the straight mineral oil.

These new oils are also effective when used in engines which already contain stabilized combustion-chamber deposits accumulated with conventional oils. Figure 11 shows data obtained on a modern V-8 passenger car engine operated under a dynamometer cycling schedule with a commercial premium-grade fuel. This engine was first operated on a conventional straight-mineral oil until the octane requirement for ordinary knock had stabilized at approximately 185 hours. The oil was then changed to a multigraded SAE 10W-30 oil. After 50 more hours of operation, the ordinary knock requirement had decreased three octane numbers, and the audible surface-ignition requirement had dropped about eight octane numbers. Similar results have been obtained by Raymond and Socolofsky[5] in road tests.

Summary

Substantial commercial gains have been made in reducing the knocking and ignition tendencies of combustion-chamber deposits via the lubricating oil route. Further improvements along these lines may result from more extensive investigation of the part that oil additives play in the fuel-lubricant-engine picture.

Original presentation was before the South Texas Section of the American Institute of Chemical Engineers, Galveston, October, 1954.

LITERATURE CITED

[1] Orelup, J. W., and Lee, O. I., "Factors Influencing Carbon Formation in Automobile Engines," Ind. and Eng. Chem., 17, 731-5 (1925).

[2] Bahlke, W. H., Bernard, D. P., Eisenger, J. O., and Fitzsimmons, O., "Factors Controlling Engine-Carbon Formation," Transactions, 26, 373-79, 388 (1931).

[3] Gruse, W. A., "Carbon Deposits in Gasoline Engines," American Society for Testing Materials, New York Regional Meeting, Symposium on Motor Lubricants, 20-34 (March, 1933).

Gruse, W. A., "Summary of Factors Causing Formation of Carbon Deposits in Internal Combustion Engines," O&GJ., 32, (27) 15 (1933).

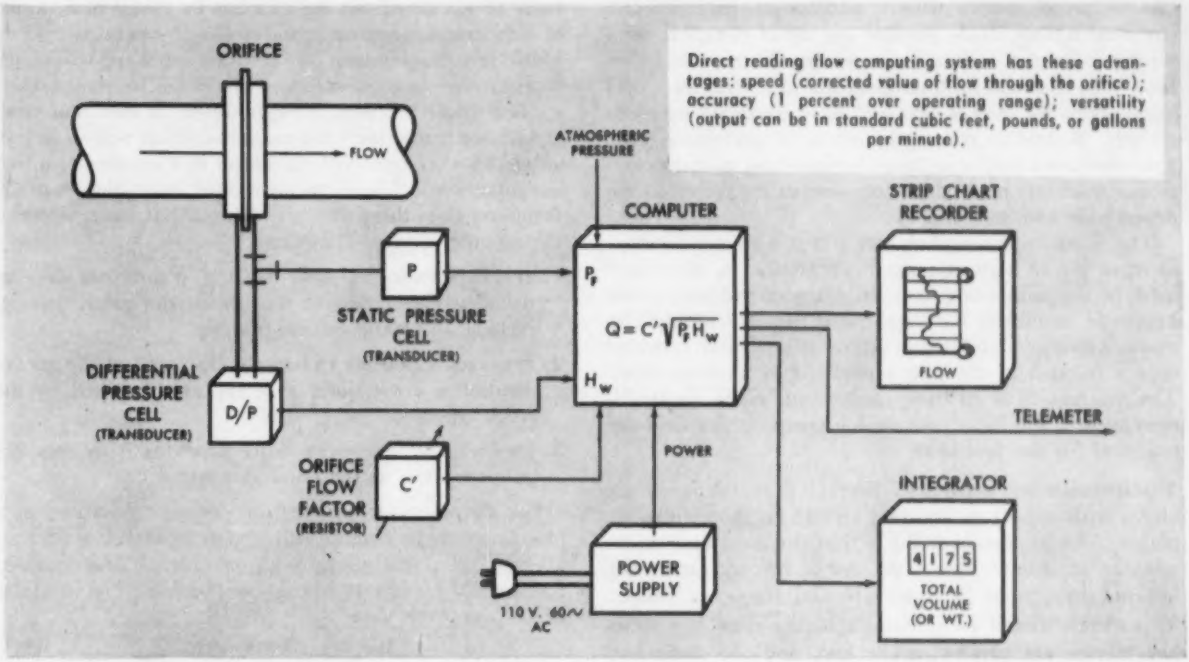
[4] McNab, J. G., Moody, L. E., and Hakala, N. V., "The Effect of Lubricant Composition on Combustion Chamber Deposits," presented at the SAE Annual Meeting, Detroit, January, 1954.

[5] Raymond, Leonard, Socolofsky, J. F., "Designing New Performance Into A Motor Oil," presented at SAE Summer Meeting, Atlantic City, June, 1954.

[6] Overcash, R. L., Hart, W., and McClure, D. J., "Crankcase Oil—An Approach to the Combustion Chamber Deposit Problem," presented at SAE Annual Meeting, Detroit, January, 1954.

[7] Hall, C. A., Warren, J. A., and McCullough, J. D., "Practical Yardsticks for Deposit Effects," presented at SAE Summer Meeting, Atlantic City, June, 1954.

[8] Williams, R. K., and Landis, J. R., "Some Effects of Fuels and Lubricants on Autoignition in Cars on the Road," SAE Transactions, 62, 57, (1954).



Direct reading flow computing system has these advantages: speed (corrected value of flow through the orifice); accuracy (1 percent over operating range); versatility (output can be in standard cubic feet, pounds, or gallons per minute).

The newest thing . . .

Analog Computer Records Flow

The computer may be installed to record routine flow calculations directly and continuously.

Frank C. Smith, Jr.,
Southwestern Industrial Electronics Company, Houston

INCREASED ACCURACY and speed in orifice meter flow measurements are made possible by a new analog computer especially designed for this purpose. It requires little power, is compact and rugged, and can be installed and maintained in the field by non-technical personnel.

The significant difference between this and previous orifice flow measurement systems lies in the fact that this device computes corrected flow as the data (differential pressure, static pressure, temperature, etc.) are fed in. Other systems record these data for subsequent computation. The advantages of continuous simultaneous computation are:

1. The computed and corrected flow figures are instantly available, thereby making possible automatic control through a feedback loop.
2. The sensing devices and the computing unit are able to follow pulsations up to 500 cycles per minute. The recorder will then make an accurate graph of the true average flow in standard units, without "painting" the chart.
3. It is unnecessary to record the input variables—static pressure, differential pressure, temperature, etc., individually. This eliminates manual computing and integrating processes. The computer provides a direct indication of flow, and also may be supplied with an accumulating totalizer or integrator simultaneously indicating true volume.
4. Corrected computations may be continuously recorded on strip charts without the possibility of human error at any stage. Frequent chart changing, visual reading, manual correcting and integrating are not necessary. Errors due to pulsations, chart shrinkage, etc. are eliminated.
5. The output of the computer may be directly connected or telemetered to dispatching stations and central accounting offices.

Based on new developments. The flow computing system is based on several new developments. The introduction of accurate and reliable sensing devices, or "trans-

ducers," which use no mercury and convert pressures into electrical signals, made possible the use of electrical computing techniques to flow measurement. These transducers have been in actual fulltime operation in several large field installations for over a year and have compiled excellent records. Secondly, mass production of computer-grade semi-conductor diodes for large business and military computing machines made these components readily available, dependable and inexpensive.

The third important link was added with the development of linear high-gain magnetic amplifiers, which are used in the computing unit, in place of vacuum tubes. Magnetic amplifiers have unlimited life, are immune to shock, vibration, and temperature effects, and consume only a fraction of the power required by vacuum tubes. The availability of all these components made the development of a single-purpose analog computer for field use practical for the first time.

Significance of accuracy. Several statements made above with regard to accuracy should be more fully explained. An important point is that the computer maintains its accuracy within 1 percent of point value at any instant, throughout its dynamic and frequency ranges. This means that if no pulsations higher than 500 cycles per minute are present in the line, and the static and differential pressure do not fall below one-tenth of their maximum values, the indicated value of flow will be within 1 percent of the true value. This is an improvement of at least 2 to 1 in accuracy and dynamic range, and several hundred times in frequency response, over conventional techniques.

As all of the errors can be either positive or negative, however, the total volume error over a long period of time is expected to be less than .1 percent.

Only the complete elimination of human and chart errors in the computing process could achieve accuracy to this degree, and no other system eliminates these variables. It should be pointed out that it is the transducers, indicators, and chart recorders which limit the accuracy of the system. The computer itself is capable of short-term accuracy in the order of .1 percent, and long-term .01 percent accuracy.

Pipe line applications. By its very nature, natural gas is a difficult commodity to measure. It is affected by so many variables, and must be measured under so many different conditions, that many schemes for its measurement have been proposed.

The most widely accepted method of measuring gas flow in large quantities involves generating a differential pressure, usually by means of an orifice plate. However, the differential pressure itself is not a direct and accurate indication of the flow. According to the AGA, flow through an orifice is given by the formula: $Q_h = C'\sqrt{h_w p_f}$, where C' is the orifice flow contant, h_w is the differential pressure, in inches of water, and p_f is the absolute static pressure, in pounds per square inch. C' is the product of factors representing the orifice, the pressure base, the temperature base, the specific gravity, the flowing temperature, the Reynold's number, the expansion factor, and the supercompressibility. Some of these vary rapidly, some slowly, and some are constant for a given installation.

It has been standard practice for years to compute the value of gas flow from these factors by means of a variety of mechanical, pneumatic, and manually-operated devices. Until the development of accurate pressure-to-voltage transducers, electrical solutions could not be conveniently applied to the problem. Now, however, at least four types of suitable transducers are available which will work into an electrical computer. In addition to a number of minor advantages which will be mentioned later, the electrical computer does three things which make it vastly superior to any other device. These are:

1. It computes in real time—that is, it indicates the corrected value of flow at the instant the gas is flowing, making automatic control possible.
2. It makes it possible to include any or all of the above-mentioned corrections, exactly as prescribed by the AGA equation.
3. Its high frequency response enables it to compute pulsating flow as the pulsations occur.

For all practical purposes the pressure pulsations in a pipe line may be considered to be sinusoidal. Consider an average differential pressure h_a, on which is superimposed a sinusoidal pulsation of peak amplitude h'. The instantaneous pressure is then

$$h_w = h_a + h' \sin 2\pi ft$$

Assuming static pressure and all other parameters to be constant, the time average flow is

$$Q = C\sqrt{\overline{h_w}} = \frac{C}{2\pi}\int_0^{2\pi} \sqrt{h_a + h' \sin 2\pi ft}\, dt$$

$$= \frac{C\sqrt{h_a}}{2\pi}\int_0^{2\pi} \left(1 + \frac{h'}{h_a}\sin 2\pi ft\right)^{1/2} dt$$

Now if we are using a damped manometer, $Q = C\sqrt{h_a}$. Therefore the pulsation error factor is

$$\frac{1}{2\pi}\int_0^{2\pi} \left(1 + \frac{h'}{h_a}\sin 2\pi ft\right)^{1/2} dt$$

which can be expanded by

$$\frac{1}{2\pi}\int_0^{2\pi} \left[1 + \frac{h'}{2h_a}\sin wt - \frac{h'^2}{8h_a^2}\sin^2 wt + \frac{3h'^3}{43h_a^3}\sin^3 wt - \frac{15h'^4}{384h_a^4}\sin^4 wt \ldots\ldots\ldots\right] dt$$

This can be integrated to give $1 - \frac{1}{16}\left(\frac{h'}{h_a}\right)^2 \ldots\ldots\ldots$

all terms above second order being negligibly small.

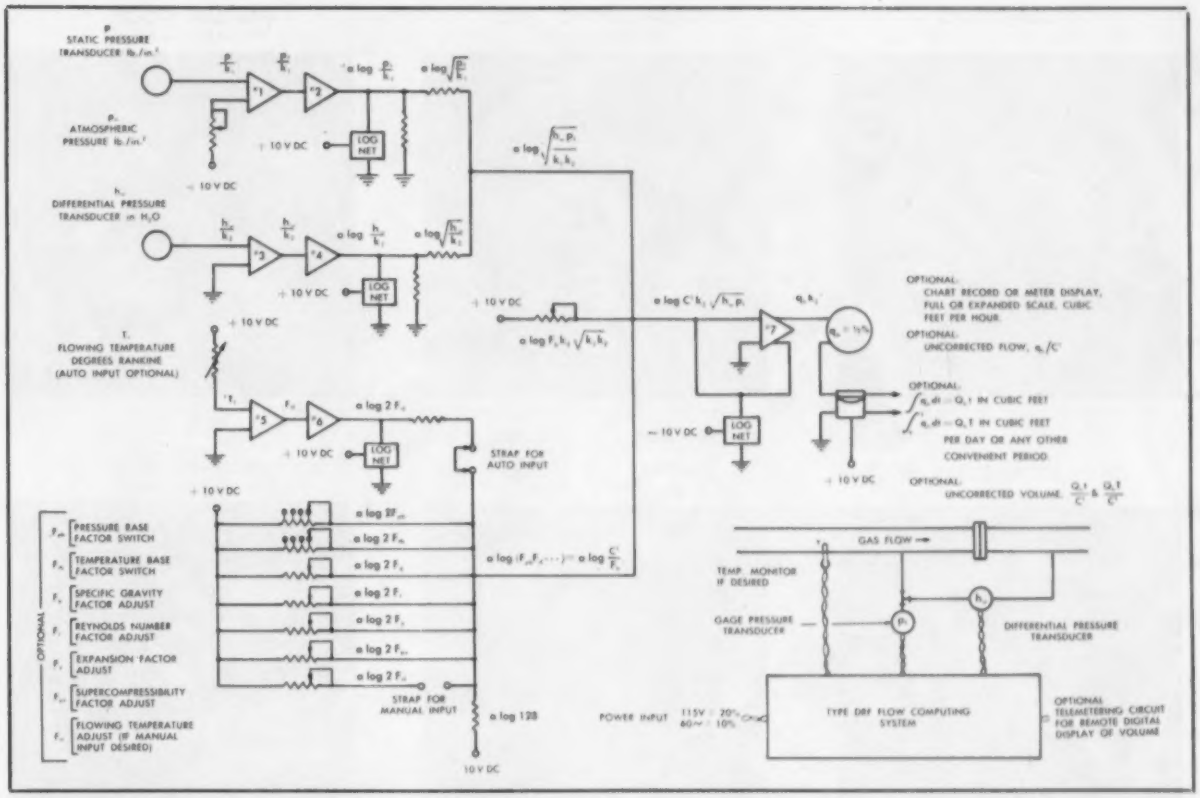
From this, an error table may be computed, as follows:

Percent Pulsation $\frac{h'}{h_a} \times 100$	Correction Factor* $\left(d - \frac{h'^2}{16h_a^2}\right)100$	Percent Error
1	99.999	0.0006
2	99.998	0.0025
5	99.984	0.016
10	99.938	0.063
20	99.75	0.25
50	98.43	1.56
100	93.75	6.25

*Sometimes called "supercompressibility" factor.

In gas flow, pulsation error may be increased by two additional variables. The static pressure may also pulsate, and the two pulsations may be out of phase. The phase angle is analogous to electrical power factor.

One further aspect of pulsating flow should be consid-


STATIC PRESSURE TRANSDUCER
ATMOSPHERIC PRESSURE
DIFFERENTIAL PRESSURE TRANSDUCER
FLOWING TEMPERATURE DEGREES RANKINE (AUTO INPUT OPTIONAL)
+10 V DC
LOG NET
STRAP FOR AUTO INPUT
STRAP FOR MANUAL INPUT
OPTIONAL
PRESSURE BASE FACTOR SWITCH
TEMPERATURE BASE FACTOR SWITCH
SPECIFIC GRAVITY FACTOR ADJUST
REYNOLDS NUMBER FACTOR ADJUST
EXPANSION FACTOR ADJUST
SUPERCOMPRESSIBILITY FACTOR ADJUST
FLOWING TEMPERATURE ADJUST (IF MANUAL INPUT DESIRED)
OPTIONAL:
CHART RECORD OR METER DISPLAY, FULL OR EXPANDED SCALE, CUBIC FEET PER HOUR
OPTIONAL:
UNCORRECTED FLOW, q_c/C'
OPTIONAL:
$\int q_c\,dt = Q_t$ IN CUBIC FEET
$\int q_c\,dt = Q_T$ IN CUBIC FEET PER DAY OR ANY OTHER CONVENIENT PERIOD
OPTIONAL:
UNCORRECTED VOLUME, $\frac{Q_t}{C'}$ & $\frac{Q_T}{C'}$
GAS FLOW
TEMP. MONITOR IF DESIRED
GAGE PRESSURE TRANSDUCER
DIFFERENTIAL PRESSURE TRANSDUCER
POWER INPUT 115V ± 20% 60~ ± 10%
TYPE DRF FLOW COMPUTING SYSTEM
OPTIONAL TELEMETERING CIRCUIT FOR REMOTE DIGITAL DISPLAY OF VOLUME

Schematic of the analog computer: Note the many optional factors, at left, which can be fed into the system. The output of the computing system can be fed into control instruments as desired.

ered. If pulsations are present in a manifold, an orifice meter on a branch line will experience pulsations, even if a valve beyond it is closed so that the net flow through the orifice is zero. The SIE system, like a conventional flowmeter, will rectify this pulsation and give an erroneous reading. If it is desired to measure such a situation accurately, however, two systems can be connected back-to-back, each measuring the flow in one direction, and the resulting currents subtracted to show true flow.

The majority of orifice installations on gas pipe lines are in the vicinity of compressor stations, which makes it particularly desirable for the equipment to measure accurately in the presence of pulsations. The power supply of the computer was also designed with such installations in mind, as it will operate on 110 volt 60 cps AC, and is not critical with regard to either voltage or frequency. It is desirable to locate the computer fairly close to the orifice, but the indicating and recording units may be several thousand feet away, connected only by a two-wire, very low-voltage circuit.

The recommended indicating device is a fan-type milliammeter with seven-inch scale, calibrated in cubic feet or pounds per minute over the operating range. A strip-chart recording milliammeter may be used to make a permanent record of flow rate, while volume is read on a digital counter. The indicating system is analogous to an automobile speedometer with a resettable odometer. Both of these indicators may also be used as control elements; for example, the flow indication may be used to control valves or compressors to hold flow at a predetermined rate regardless of pressure variations, or the totalizer may be used to close a valve when a certain weight or volume of gas has passed through the orifice. These functions are especially applicable to blending operations.

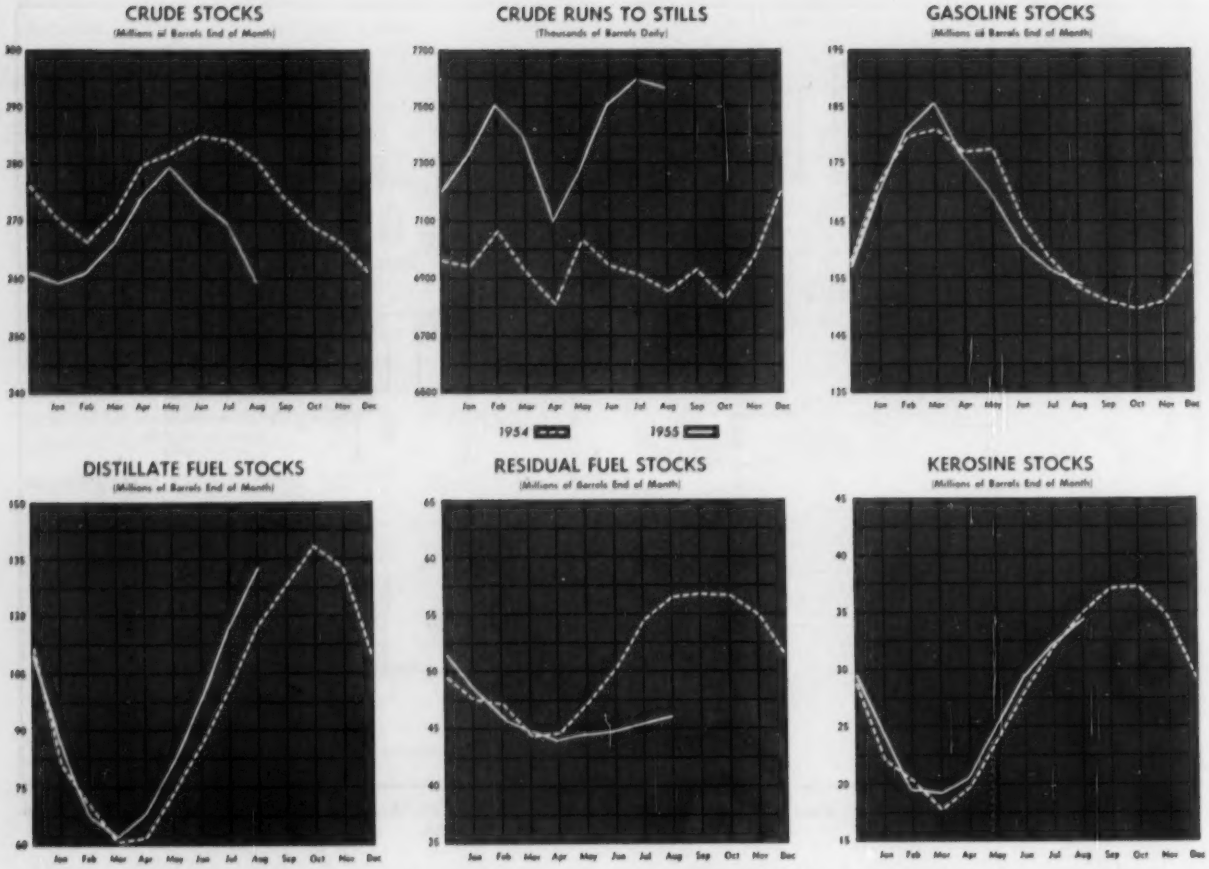
One of the most important features of the flow computer, however, for compressor station installations, is its ease of maintenance. Unskilled personnel can check its accuracy within a few minutes, using only one simple test instrument. All units subject to error or failure are easily replaceable, but it is extremely unlikely that failure will occur because there are no moving parts or vacuum tubes, and the whole unit can be hermetically sealed.

The rotary converter which supplies power to the computer and transducers has no brushes or starting switches, and will require bearing maintenance no more than once a year. The transducers are equally durable, and the strip-chart recorder will require paper and ink less often than the usual circular-chart type.

This article was presented as a paper at the Tenth Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas, and sponsored by the Southern Gas Association.

ACKNOWLEDGMENT

The author expresses appreciation to T. L. Novosad and R. F. Bukacek for information on gas measurement techniques, B. E. Davis for development of basic computing techniques, and to J. A. Crawford for the development of the integrator circuit.



Taking Stock

Cecil W. Smith,
Economics Editor

- Gasoline output at highest level
- Distillate stocks hit new peak
- Refining rate eased slightly

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
August	6,583	7,163	285,352	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,623	7,599	269,642	3,732	156,627	286	32,339	1,590	118,367	1,114	45,325	789	1,085
August	6,666	7,579	259,680	3,778	153,694	297	34,702	1,713	132,345	1,106	46,550	743	1,090
Week Ended:													
9–16–55	6,684	7,471	255,463	3,708	152,165	300	35,726	1,643	141,229	1,049	46,700	653	977
9–17–54	6,196	6,969	272,695	3,407	151,787	330	37,644	1,435	124,021	1,101	57,268	584	874

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

FOR CONDENSER AND HEAT EXCHANGER TUBES AND PLATES SPECIFY

Revere

CUPRO-NICKEL—30%, 10%
ADMIRALTY METAL
ARSENICAL COPPER
ALUMINUM BRONZE—5%
MUNTZ METAL
REVALON (ALUMINUM BRASS)

• Correct selection is essential if tubes and plates are to serve with the maximum economy and minimum trouble. The Revere Technical Advisory Service and Revere Research Department are always ready to collaborate with equipment manufacturers and operators in specification matters. • When it is time to re-tube, remember that conditions may have changed since the original installation, and that it may be wise to re-check before ordering new tubes. • To take advantage of Revere's knowledge of copper and copper alloy tubes for all industrial purposes, get in touch with the nearest Sales Office. See your telephone book or write direct. Send for helpful booklet, "Life Extension for Condenser Tubes." Free.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

For more data on advertised products, use Readers' Service Cards, last page.

Valuable Reading Ahead

HERE'S A *QUICK LOOK*
AT THE DEPARTMENTS IN THIS ISSUE

How To Do It — PAGE 180

KEEP GOING for some quick ideas that will mean money in your pocket, greater efficiency in your plant.

Who's Building — PAGE 184

KEEP GOING for a rapid-fire summary of construction activity in our mushrooming industry along with a quarterly "boxscore" of building projects.

What's Happening — PAGE 230

KEEP GOING for some tersely told information on the highlights of industry happenings.
KEEP GOING for a newsy roundup of the activities of men you know.

Heard at Meetings — PAGE 266

KEEP GOING for quick accounts of important gatherings.

Suppliers' Notes — PAGE 272

KEEP GOING for a glimpse at personalities in the supply industry.

New Books — PAGE 284

KEEP GOING for capsule digests of books that will interest you.

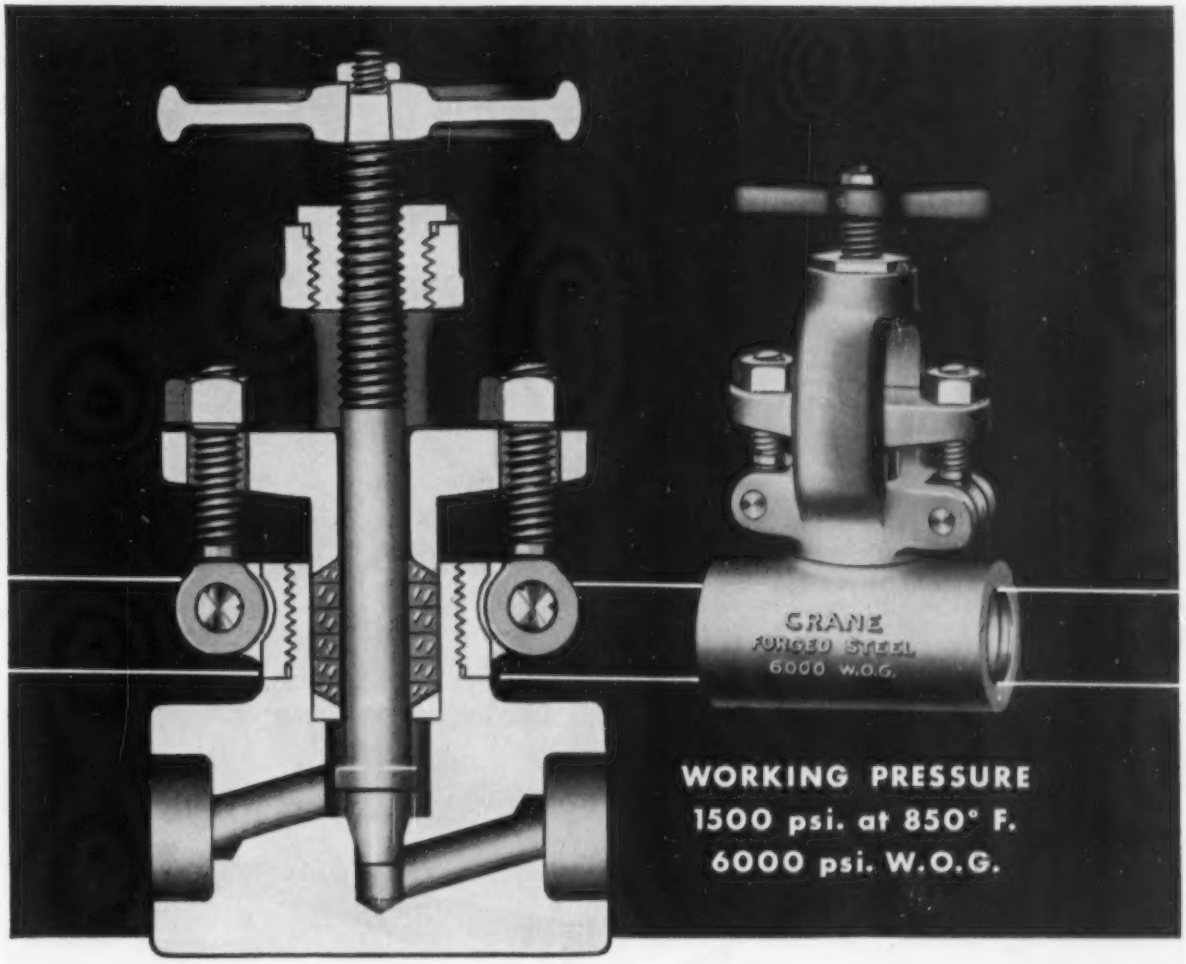
New Equipment — PAGE 291

KEEP GOING for a fast description of the best in new mechanical developments.

Service Cards — PAGE 307

KEEP GOING for a quick, convenient way to get more information on new equipment, literature, as well as products and services offered by advertisers.

Now Available



New Crane Forged Steel Instrument Valves

Been looking for an exceptionally rugged, compact, and low-priced stop valve for your small hydraulic or high-pressure, high-temperature instrument lines?

Crane has developed it—sizes ¼", ⅜" and ½", in both screwed and socket-welded patterns. It's the all-new Crane Forged Steel Instrument Valve, and you can specify it now for immediate delivery.

Will Handle Many Services

Note closely the over-all design and construction shown above of this new Crane valve. Oversized stuffing box—heavy-duty Crane Exelloy stem with integral disc—bolted gland—swinging gland eye bolts—outside screw and yoke construction—all add up to the high performance and low maintenance you want in a valve for your instrument panels, orifice meters, bypass and gauge lines, regulator leads, and other hydraulic and high pressure/temperature lines.

Literature on Request

These rugged, low-cost stop valves are built for 1500 psi. at 850° and 6000 psi. W.O.G. Construction and materials are job-engineered by Crane experts—backed by a century of quality manufacturing, matchless experience. You'll want complete information on the all-new Crane Forged Steel Instrument Valves. Contact your Crane Representative, or write to Crane Co., General offices, Chicago 5, Illinois—Branches and Wholesalers serving all industrial areas.

CRANE CO.

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .

$10 is paid for each accepted idea. Mail to Editor, Petroleum REFINER, P. O. Box 2608, Houston 5, Texas

FIGURE 1—Old, rotted split tie, completely deteriorated, probably due to poor drainage in that area of the track.

FIGURE 2—Completely deteriorated track structure. Note battering of rail at rail ends at the joint.

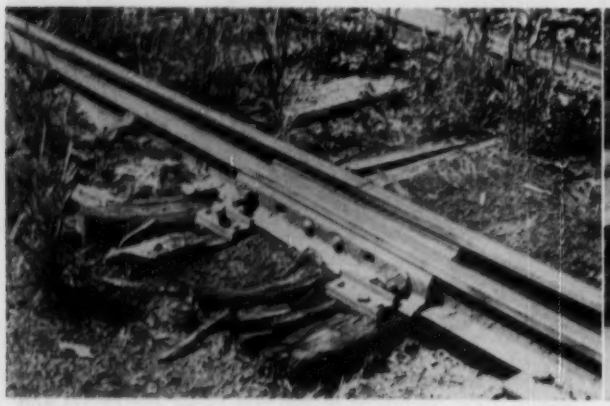


FIGURE 3—Close-up of switch heel block. Note general deterioration of ties, missing bolts, and loose bolts. This condition endangers the entire system.

FIGURE 4—Badly worn frog, reflecting the result of a general lack of maintenance. The frog is cluttered up with debris and bolts are loose.

Checking Up on In-Plant Rails

RAILROAD sidings within a plant's property line are one of the most neglected of plant maintenance.

This neglect results in inefficient movement of materials, lost time, money and labor, and conditions that may lead to serious equipment damage or injury to personnel.

As an aid in evaluating the condition of plant trackage and alleviating any deficiencies, rail specialists of L. B. Foster Company, Pittsburgh and New York, point out a few of the many poor track conditions that usually exist so that maintenance men can recognize and correct them:

1. Poor drainage around ties, loose bolts and excessive rail expansion should be corrected immediately. Both loose bolts and rail expansion cause excessive rail wear that lead to costly down-time, delays in shipments and deliveries.

2. Old or worn tie plates should be replaced. This condition will produce

New Sarco Thermodynamic Steam Trap practically eliminates maintenance!

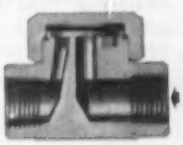
Only moving part—a hardened Solid Stainless Steel Disc—practically wear-proof!

SOME OF MANY ADVANTAGES

1. Same trap for all loads and pressures 10-600 psi.
2. *Stainless steel throughout*...therefore immune to both internal and external corrosion; safe in fire hazard locations.
3. Closes tight on no load. Operates against back pressures up to 50% of inlet pressure.
4. Not affected by superheat, water-hammer, vibration.
5. Smallest inventory of spare parts.

SIMPLICITY—to the Nth degree!

No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Three simple parts...machined from stainless steel bar stock. Only one moving part. What could be simpler?



SARCO COMPANY, INC.

2146-B

Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

Please send me: ☐ Bulletin 255-44
☐ A Sarco Thermodynamic Steam Trap for 60-day trial. Size_____ for installation on_____

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

For more data on advertised products, use Readers' Service Cards, last page.

loosening of bolts and spikes, and rail break at joints due to heavy batter.

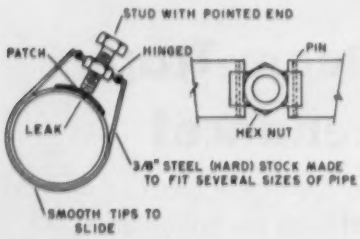
3. Check for deterioration of rail ties. This condition results from poor drainage and can cause loose bolts, damage to rail at joints and rail expansion.

4. Poor switch conditions endanger the entire track operation. This situation may be due to loose or missing bolts, heavy growth and poor drainage.

5. Remove mud and debris collected between rail and switch. This condition will cause trouble, including possible derailment. It also prevents the switch from closing properly.

6. Check for badly worn frogs—two rail "V's" butted together. Wear on frogs is a sign of poor maintenance such as collection of debris and pebbles that prevent proper functioning.

7. Make sure that rail switches are adjusted properly so they can open and close efficiently. Poorly adjusted switches can result in damage and possible failure of entire track system.

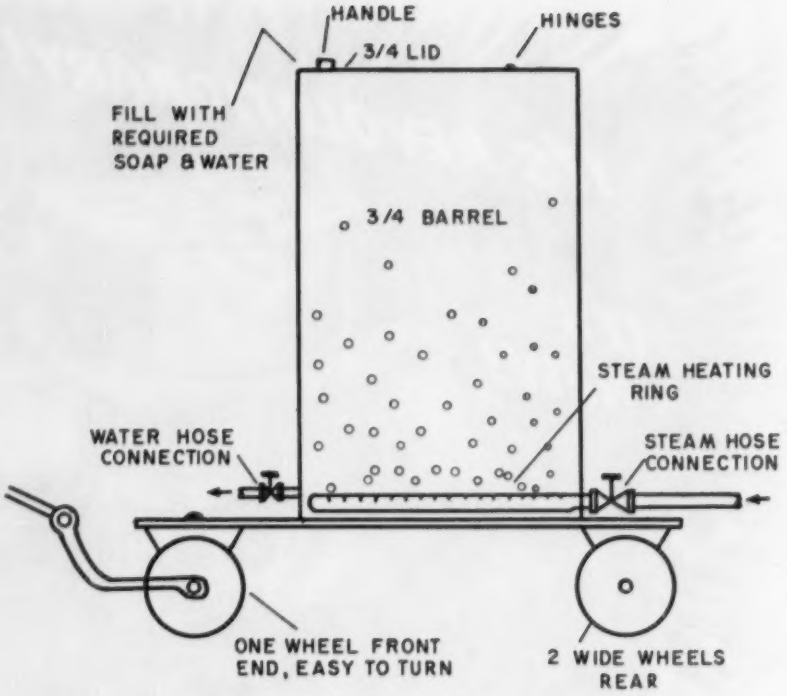


Make a Device to Hold Welder's Patch in Place

When a leaking line must be patched while the line is in service, it is difficult for the welder to position the patch over the hole and to keep it there long enough to spot weld it. Here is a device which will help him do just that:

A pointed-end stud fits against the patch. The stud in turn is held in place by a hinged hexagonal nut connected to a U-shaped rod stock fitting around the pipe.

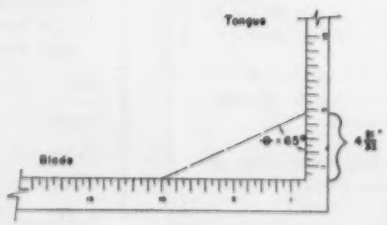
Once the patch is in place, the stud can be screwed down so sufficient pressure is applied to hold the position. The welder is then free to make the necessary welds. The U-shaped rod stock can be bent to fit several different sizes of pipe.



Lay Out An Angle With Carpenter's Square

All you need is an ordinary carpenter's square and a trig table. To lay out the angle with these two tools, first do a little arithmetic. If the angle is greater than 45 degrees, subtract it from 90 degrees; if less than 45 degrees, read directly. Look up the tangent in the trig table; multiply this by 10. Convert this product to inches and mark the distance off on the blade of the square. (If the angle is greater than 45 degrees, mark off on the tongue as shown.) Connect to the 10-inch mark on the opposite scale to get the angle.

As an example, to lay out an angle of 65 degrees, first subtract this from 90 degrees, giving 25 degrees. The tangent of 25 degrees is .4663. Multiply by 10 and the answer is 4.663. Measure this off in inches on the tongue and connect to the 10-inch mark as shown.



Scrub Cart Will Ease Job of Cleaning Floors

To ease that necessary task of cleaning the concrete floors around compressors buildings and control houses, here is a handy cart where the cleansing solution can be mixed and heated.

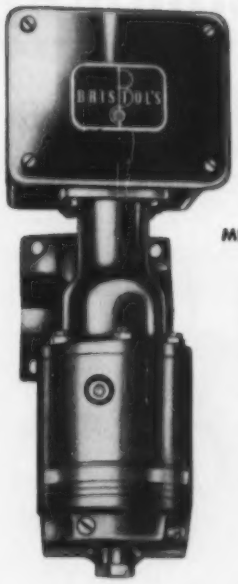
It is made by cutting a drum down to about three-quarters of its original size, fitting it with a lid, and mounting on a shop-made three-wheel cart. A steam-heating ring is installed in the bottom of the drum and the connections are made for a steam hose and a water hose. Soap is dumped in the top and the drum is filled through the water hose connection. Injection of steam into the ring at the bottom heats the solution for maximum effectiveness. The solution is drained from the barrel through the water hose connection onto the floor.

How to Do It Ideas Are Worth Money

Send your ideas with photos or sketches to Editor, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

WHAT'S NEWS AT BRISTOL . . .

FIRST instrument system that carries out BASIC–GRAPHIC PANEL idea completely!



1

METAGRAPHIC TRANSMITTER

SUPPLIED IN A VERY WIDE VARIETY OF SPANS AND RANGES: For example, absolute pressure instruments are made in ranges as low as 5mm mercury absolute. Pressure instruments as low as 5 inches water to 10,000 psi. Over-range protection available up to 400% over-range.

A WIDE SELECTION: For example, there are 35 receiver and 34 controller models and the widest variety of transmitters on the market. A model can be found among these that will exactly meet any requirement.

FULL PLUG-IN SERVICE: Change recorder to an indicator or vice versa in 10 seconds with ABSOLUTELY NO INTERRUPTION WHATSOEVER TO AUTOMATIC CONTROL.

Pull complete chassis out (one-piece chassis – no tools required). With chassis removed you get the same automatic control as before.

Change from one model to another or if trouble is suspected in a plug-in unit, the doubtful unit can be replaced by a spare while the suspected unit is checked in the service shop – out-of-service time is thus eliminated.

CONTINUOUS VALVE POSITION INDICATION on *same instrument scale as set point scale*, gives continuous data on control valve position – makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

SCALES ARE SCIENTIFICALLY DESIGNED for instant, error-free readability – a new degree of close-up, as well as distance readability.

Write today for more details. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. 5.14

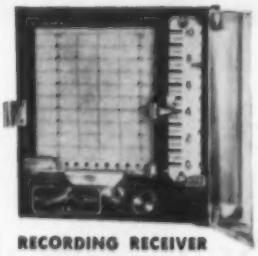
METAGRAPHIC INSTRUMENTS MEASURE, RECORD, INDICATE, AND AUTOMATICALLY CONTROL

Pressure • Vacuum • Absolute Pressure
Differential Pressure • Liquid Level • Flow
Temperature and • Mechanical Motion

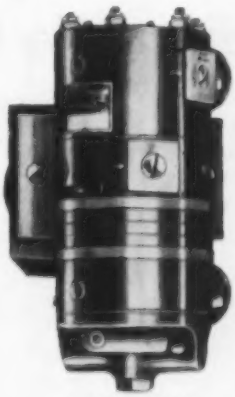
NO INTERRUPTION WHATEVER TO AUTOMATIC CONTROL when receiver chassis is removed.

OFFERED FOR UP TO THREE MEASURED VARIABLES – with air pressure regulators or air loaded regulators – three-position manual-automatic transfer valves for automatic control and *six-position (on the same knob) transfer valves for cascaded control.*

2



RECORDING RECEIVER



CONTROLLER

3

VARIETY AND FLEXIBILITY: The most flexible and complete line of controllers offered – 34 different models.

PLUG-IN FLEXIBILITY: Controllers are designed for full plug-in interchangeability for change of control mode or service. This means no process down-time for maintenance – no off-specifications product.

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

TRADE MARK BRISTOL'S

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Who's Building . . .

Construction Boxscore Starts on Page 203

New gasoline plant has daily capacity of 10 Mmcf.

Semi-Portable Gasoline Plant Built for Venezuela Company

. . . New absorption-type unit is almost self-operating.

BROWN & ROOT, INC., has built a packaged, semi-portable, absorption-type gasoline plant which runs unattended except for a daily checkup by the operator.

Containing safety shut-off devices, the plant was designed for Mene Grande Oil Company, Venezuelan affiliate of Gulf Oil Corporation. It is especially suited for use in remote areas, since most of the equipment and pipe lining is pre-assembled, greatly reducing labor in the field.

Tailor-made for special conditions, the plant will process 10 Mmcf. of 600-pound gas a day, turning out 26-pound RVP stabilized gasoline. It is expected to return 1½ gallons of product for every 1000 cubic feet of gas.

The bubble columns, fired heater and cooling tower will be installed in the field. The plant is mounted on two 10 x 24-foot skids.

Fast Tax Write-Offs To Cover New Goals

A new government policy on accelerated tax amortization is due to set a new goal of 9 million barrels a day for the petroleum-refining industry. This will be 250,000 barrels more than the old goal, which was about filled when fast tax write-offs were suspended.

In addition to a new goal in refining, another 25,000 barrels a day of alkylate capacity will be set up. This will be in addition to a previous 30,000-barrel increase in the alkylate goal. Projects to make alkylate will win approval for 100-percent amortization.

Refining projects approved for rapid amortization probably will have to meet stiffer standards, however. For example, the item of "dispersal" likely will be taken into account.

The Office of Oil and Gas, which processes applications for fast tax write-offs sought by the petroleum industry, has a backlog of applications for refining projects. If these applications comply with the new

For more data on advertised products, use Readers' Service Cards, last page.

What's the Best Temperature
Reformer Reactors, Cat
for Column Reboilers and

WHY is it the best for these critical gas-fired furnace temperature applications? Because *both* the TRANSAIRE Transmitter and the TRI-ACT Controller respond practically instantaneously and with the right amount of correction to control the slightest temperature variation. Result—*truly uniform furnace outlet temperatures*. In fact, field experience has proven that there is no better control system on the market at any price for these applications. Here's why:

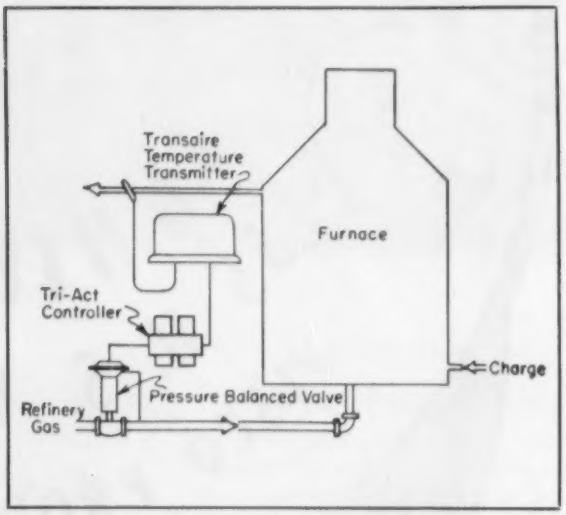
1. Extreme sensitivity in the transmitter (1/10 of 1%) signals the minutest of process changes to the controller.

2. SPEED-ACT* (rate action) permits the signal from the transmitter to follow accurately the dynamic changes in process, overcoming inherent process and well lags.

3. The sensitivity of the TRI-ACT controller (1/10 of 1%) provides instantaneous corrective valve action.

4. The TRI-ACT circuit (PRE-ACT*—rate action—ahead of reset and proportional) permits higher PRE-ACT settings which produce corrective valve action of just the right magnitude for straight line control.

The TRI-ACT controller is the *only* pneumatic controller that has such an advanced circuit.



The TRANSAIRE Transmitter, with its short range spans of 100, 200 or 400°F. is particularly adaptable to these high temperature applications. In fact, it provides the same quality of control on cat crackers with temperatures up to 1200°F.

*Trade Mark

The Taylor TRANSAIRE® Temperature
the TRI-ACT® Controller . . . and it

Control System for... Feed Preheaters to Crackers and Crude Units, and Furnaces Hot Oil Circulating Systems?

BENEFITS TO YOU

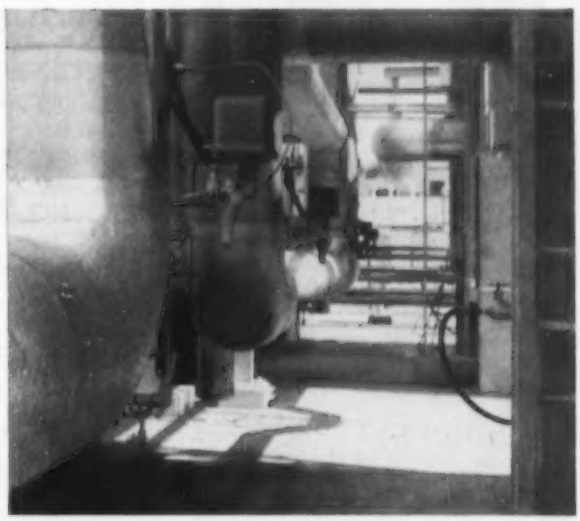
1. You are able to maintain constant optimum temperatures on feeds to cat crackers, reformers, reactors, etc.

2. You obtain higher yields of specification product.

3. Your operating costs are substantially reduced.

4. The on-stream life of your furnace is considerably extended because the TRI-ACT controller reduces coking which usually results from variations in load or fuel supply.

Call your Taylor Field Engineer for more detailed information about this highly successful system, or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.



Taylor TRANSAIRE *Temperature Transmitters in use on Reformer Reactor Pre-Heaters at a well known SouthWestern gasoline plant.*

Taylor Instruments MEAN ACCURACY FIRST

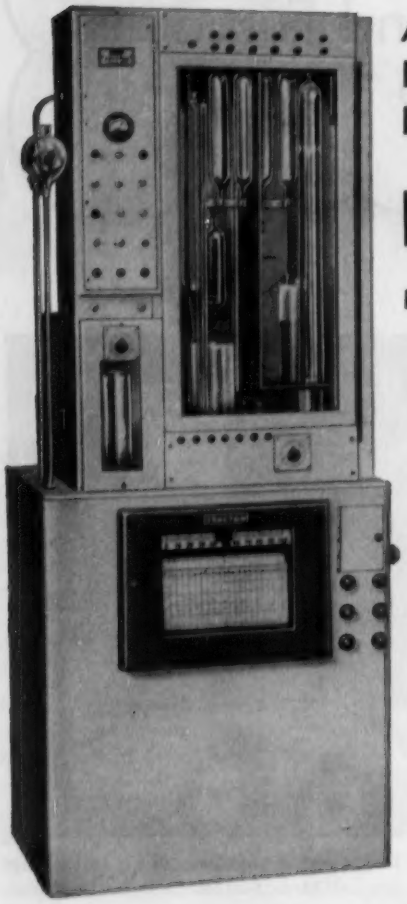
Transmitter, coupled with costs the LEAST!

For more data on advertised products, use Readers' Service Cards, last page.

BURRELL

"For Scientists Everywhere"

presents **THE FRACTON®**



A New Instrument For Analysis of Light Hydrocarbons

2 to 3 Times Faster!

For:

NATURAL GAS

GASOLINE PLANT GASES AND LIQUIDS

REFINERY GASES

CYCLING PLANT GASES

LIQUEFIED PETROLEUM GASES

SYNTHETIC RUBBER INTERMEDIATES

PLASTIC INTERMEDIATES

PETROCHEMICAL GASES

and other light hydrocarbons

THE FRACTON CUTS ANALYSIS TIME AND EXPENSE, IMPROVES ACCURACY AND IS EASIER TO OPERATE

Request your Copy of FRACTON BOOKLET No. 82

The Fracton separates, identifies, collects and measures the components and records the analytical data in fifty to seventy-five percent less time than former methods. Users get superior accuracy and reproducibility with this new improved and simplified instrument.

® TRADEMARK

BURRELL CORPORATION

2223 FIFTH AVENUE, PITTSBURGH 19, PENNSYLVANIA

Manufacturers and Distributors of

SCIENTIFIC APPARATUS and LABORATORY CHEMICALS

Who's Building . . .

more selective standards, they will immediately fill the revised goals for refining capacity.

The new goals will be in effect until the last of the year, when a new study will decide which of them should be continued.

Socony Mobil Oil Company, Inc., has scheduled a catalytic-reforming unit for construction at its Buffalo, N. Y., refinery. The unit, to employ the Sovaforming process will be built for a daily capacity of 9000 barrels. The new installation will be built by Arthur G. McKee & Company. It is due to be completed by May 1956.

Canadian Oil Companies, Ltd., purchasing Anglo-Canadian Oil Company, Ltd., will acquire a $25-million refinery now being expanded at Sarnia, Ont. The three-year construction program will increase the plant's daily capacity to 25,000 barrels in 1956 and 30,000 barrels in 1957.

Caribbean Refining Company has gone on stream with Puerto Rico's first refinery, a 10,000-barrel-a-day plant at San Juan, and a second Puerto Rican refinery will be completed later this year at Ponce on the south coast. Engineering and construction of the $11-million San Juan installation was handled by The Fluor Corporation, Ltd.

The Ponce refinery, a 25,000-barrel-a-day plant being built for the Commonwealth Oil Refining Company by The Lummus Company, was expected to cost $25 million. Process equipment for the new refinery will include a catalytic-cracking plant and reforming facilities.

Ashland Oil & Refining Company will close down the refinery operated by its subsidiary Aetna Oil Company at Louisville, Ky., to tie the 10,000-barrel-a-day plant into a new petrochemical operation. No decision has been announced on what chemicals will be produced.

When the Louisville plant is closed late in October, an equivalent capacity will be started up at the Ashland refinery in Catlettsburg, Ky. Meanwhile, Ashland plans for expansion also include the installation of a 6000-barrel-a-day catalytic reformer at the Buffalo refinery operated by the affiliated Frontier Oil Refining Corporation.

Tide Water Associated Oil Company has three of the world's largest refining units under construction at the site of its new 130,000-barrel-a-day refinery near Wilmington, Del. Foundation construction has started on the second and third units—the refinery's 130,000-barrel-a-day crude unit and a 42,000-barrel-a-day fluid coking plant. Work was already underway on the first process unit, a fluid catalytic cracking plant with a daily capacity of 102,000 barrels. Some 1700 construction men are working on the site.

The Texas Company has placed on stream at its refinery in Lockport, Ill., a 10,850-barrel-a-day catalytic-reforming unit. The new installation, a combination Platformer-Unifiner, is the ninth such unit to go into operation at Texaco refineries.

Alterations in the Lockport plant's alkylation facilities also are under way, with

Lummus Coker for Yorktown Refinery Will Handle Heaviest Charge on Record

The Delayed Coking Unit for the new Yorktown, Virginia refinery of The American Oil Company will handle the heaviest feed ever charged to a Delayed Coker. The Lummus Company has been selected to design and construct the unit. Special techniques have been developed in Lummus laboratories and pilot plants to handle such heavy stocks.

Charge to the Unit will be vacuum reduced crude which will have 25.0% Conradson Carbon and an API gravity of 6.1°. SFS at 210°F is 6000. The products will be gas oil, gasoline, gas and C4's, plus 600 tons per day of coke. The Unit is also designed to handle lighter stocks at a maximum capacity of 9,660 B/D.

The Coking Unit will have four coke drums. The Lummus Heater, which is the heart of this process, incorporates the critical design factors to meet the wide range of charge stocks and throughputs.

The new coker will come on-stream late in 1956. As an integrated part of the Yorktown Refinery, it will help supply motorists' demand for more of the American Oil Company's premium unleaded motor fuel, "Amoco-Gas," marketed in 18 states from Maine to Florida.

Lummus has designed, engineered and constructed a large percentage of this country's modern coking capacity. Lummus can build a coker . . . or a complete refinery . . . for you. Let Lummus engineers show you how 50 years experience with over 700 major installations will produce maximum return on your capital investment.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

AMOCO

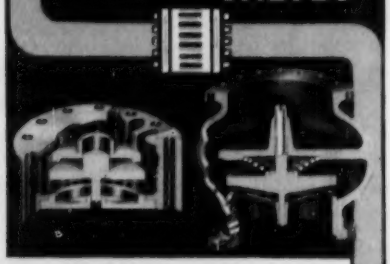
LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS
FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

For Positive Low Cost
PROTECTION
of your piping system
SILENT SERVICE SINCE 1929

WILLIAMS-HAGER
FLANGED
Silent
CHECK VALVES



for all piping systems handling water, acids, oils, gas, alkalies, other fluids.

Built to meet exacting service requirements—in sizes from 1" to 20"—Williams-Hager Check Valves will eliminate costly and dangerous *water hammer* in your piping system. Can be installed in horizontal, vertical or angular position. No special tools required. Send for Bulletin 654!

MAIL COUPON TODAY...

THE WILLIAMS GAUGE CO., INC.
151 Stanwix St., 2 Gateway Center
Pittsburgh 22, Pa.

Please send me a copy of Bulletin 654 on Williams-Hager Flanged Silent Check Valves.

NAME_____ TITLE_____ COMPANY_____ ADDRESS_____ CITY_____ ZONE___ STATE___

THE WILLIAMS GAUGE CO., INC.
2 Gateway Center • Pittsburgh 22, Pa.

Who's Building...

completion scheduled for April 1956. Changes in the unit are expected to increase its alkylate yield from 3200 barrels a day to 4400 barrels.

Last year Texaco's investment in domestic refining facilities exceeded $72 million, most of it spent to increase the octane number of its motor fuels. The company's nine reforming units have a daily capacity for 101,000 barrels of reformate.

A tenth combination unit is under construction for The Texas Company at its Casper, Wyo., refinery. The 4800-barrel-a-day unit is expected to go on stream next spring.

The Dow Chemical Company is due to start construction on facilities to make styrene at the company's Torrance, Calif., plant. The new plant will be in production by early 1956.

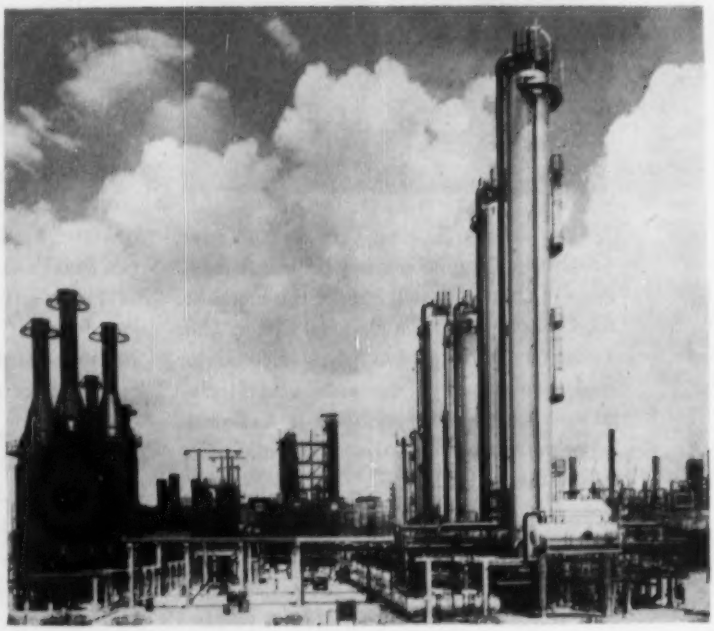
The British Petroleum Company will build an oil-gasification unit at its Kent, England, refinery. The unit, Britain's first, will produce gas at a rate of 15 to 20 Mmcf. a day, using between 1200 and 1400 barrels of oil. Four such units will be installed eventually, raising the plant's output to 80 Mmcf. a day.

Goodrich-Gulf Chemicals, Inc., planning to build a pilot plant to produce a new synthetic rubber, has picked Avon Lake, Ohio, as the location for $750,000 installation. Now in the engineering stage, the plant, to be erected by company personnel, will be in operation in about a year.

Du Pont Company plans to expand its new plant, now under construction at Antioch, Calif., to make sodium, ethyl chloride, trichlorethylene and perchlorethylene.

The new addition will be integrated with the tetraethyl lead and refrigerants plant

Gulf Reformer on Stream



Gulf Oil Corporation has put in operation a 29,000-barrel-a-day catalytic reformer at its refinery in Port Arthur, Texas. The unit, a Platformer, is the fourth and largest of four similar units put on stream at Gulf refineries this year. The other new units are at Philadelphia, Toledo and Cincinnati.

The Port Arthur installation, covering four acres of the refinery, upgrades heavier, low-octane portions of gasoline to high octanes. It will make blending stock for aviation gasoline as well as automotive fuels. The three other units blend stocks for automotive fuels only.

Designed by Universal Oil Products Company and erected by The Fluor Corporation, Ltd., the new reformer is the largest of its type ever built. A special catalyst is used in the process, and the first charge cost about $800,000.

Other additions to the Port Arthur refinery include two refining units which will also be among the largest in the world. Structural work is underway on a fluid catalytic cracker with a daily thruput of 68,000 barrels and a 100-barrel-a-day crude topping and vacuum still. Both will be in operation early in 1956.

The company also is considering the installation of a third ethylene plant at Port Arthur. The new unit would be of a similar size to the second which was completed recently. The second ethylene unit has a capacity of 220 million pounds a year. It and the original unit have a combined annual capacity of 365 million pounds.

Who's Building. . .

scheduled for completion late in 1956. The new unit, to be designed and engineered by Du Pont's Engineering department, will go on stream early in 1957.

Sodium and ethyl chloride will be used as ingredients in making tetraethyl lead, while the new unit's other two products will be used as solvents. Propane, one of the primary raw materials, will be brought to the plant from nearby refineries.

Phillips Chemical Company, planning to expand its petrochemical facilities at Houston and Sweeny, Texas, has awarded a contract for the major portion of construction work on its projected $31,525,000 plant to make polyethylene at Houston.

The plant, with a daily capacity of 301,000 pounds, will be erected by Farnsworth and Chambers Company, Inc. The company's 329,000-pound-a-day ethylene plant at Sweeny, to be connected by a 75-mile pipeline, will be built by Stone & Webster Engineering Company.

The polyethylene plant in Houston is due for completion in August 1956. The Sweeny unit will be finished in December 1956. It is expected to cost $12,357,000.

Magnolia Petroleum Company has plans for a natural gasoline plant near Attica, Kansas. The new installation, expected to cost $3 million, will turn out an annual product worth $1.5 million. It will take some 40 Mmcf. of gas a day, producing 20,000 gallons of gasoline, plus 16,000 gallons of propane and 12,000 of butane.

X-L Refineries, Ltd., building a 2000-barrel-a-day refinery at Dawson Creek, B. C., expects to have the $2-million installation in operation by the end of the year. The site is one of the farthest-north refinery locations in North America.

Dawson Creek crudes will be charges to the refinery's crude unit, and naphtha fractions will be processed by a 500-barrel-a-day Houdriformer, which consists of a guard case pre-treating section and catalytic reactors. The plant's equipment also will include a thermal cracker.

Construction is being handled, under a joint contract, by B. D. Bohna & Company and E. V. Lane Corporation. Engineering for the refinery units was done by Koch Engineering Company, Inc.

Texas Gulf Producing Company has started construction on a $1,250,000 expansion of its natural gasoline facilities near Odessa, Texas. The project will double the plant's capacity. When completed, the unit will produce 140,000 gallons of liquid hydrocarbons a day. Intake capacity will be increased from 15 Mmcf. a day to some 35 Mmcf.

Continental Carbon Company will expand its carbon black plant at Eunice, N. M., to produce 25-million pounds of semi-reinforcing furnace black a year. The new plant, to use natural gas as a raw material, will be on stream early in 1956.

Aetna Oil Company will convert its Louisville, Ky., refinery from refining crude oil to making petrochemicals. The company, a subsidiary of Ashland Oil & Refining Company, will move its refining operations to Catlettsburg, Ky., where

Laclede-Christy Castables deliver money-saving, trouble-free service because they are especially designed for use by refineries.

Porelite V. L. is used for its high insulating properties and lightness in weight per cubic foot.

Firmcast is used for extra strength and high resistance to abrasion. Both products can be applied by gunniting with minimum amount of waste.

Porelite V. L. and *Firmcast* have passed the test and service requirements at major refineries.

Laclede-Christy also offers the service of experienced personnel who can help you solve special problems. Why not take advantage of this extra service?

LACLEDE-CHRISTY COMPANY

DIVISION OF H. K. PORTER COMPANY, INC.
2000 Hampton Avenue • St. Louis 10, Missouri
Mission 7-2400

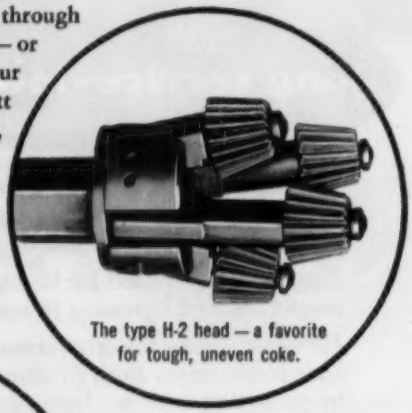
For more data on advertised products, use Readers' Service Cards, last page.

clean-outs go fast with LAGONDA

The famous Lagonda 1100 Series refinery motor, with Type UO cutter head. A popular combination.

YOU'LL BE BACK ON STEAM in record breaking time when these rugged Lagonda tube cleaners get on the job. Naturally it's important you have the right super-hard cutter head and 1100 Series motor for your particular coke application. Call in your local Lagonda man to look over the situation; he'll gladly recommend a fast-cutting unit that will zip through coke in a jiffy. Contact him — or write us direct in time for your next clean-out. Address Elliott Company, Lagonda Division, Springfield, Ohio.

The long-surface Swing frame head—designed for wide tolerance tubes.



The type H-2 head — a favorite for tough, uneven coke.

Catalyst Cleaner — tops for removing spent catalyst from tubes and piping it away.

YB-8A

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Who's Building . . .

Ashland does a major portion of its refining. The Louisville plant an 11,000-barrel-a-day unit, will continue to distribute gasoline and other petroleum products.

Shell Oil Company, with construction about 90 percent complete, has started crude-oil distillation at its new Anacortes, Wash., refinery. Due for completion late about 90 percent complete, has started this year, the 50,000-barrel-a-day plant will not be dedicated until summer 1956.

California Spray-Chemical Corporation has been cleared by the French government to build a $1.5-million plant, for manufacturing captan in France. The new facility, with production sufficient to supply the French and other European markets, is to be on stream by fall 1956. The company is a subsidiary of Standard Oil Company of California.

Kimball Gas Products Company has completed a new high-pressure absorption type gasoline plant in Kimball County, Neb. The new unit will process 7.5 Mmcf. of gas a day.

Bureau of Mines will build a new helium plant at Exell, Texas. Stearns-Rogers Manufacturing Company will receive $240,000 for preparing the engineering designs, specifications and construction drawings.

Buildings and equipment are expected to cost $4 million. Separate gas-separation equipment, to be designed by the bureau and purchased separately, will cost another $2 million.

Carbide and Carbon Chemicals Company has scheduled construction of a new ethanolamines unit at its Seadrift, Texas, plant. Completion of this facility in the fall of 1956 will more than double the company's ethanolamines capacity.

Pitt-Consol Chemical Company is setting up a cresylic-acid refinery at Newark, N. J. The newly-formed subsidiary of Pittsburgh Consolidation Coal Company will install new facilities and renovate existing equipment purchased from Reilly Tar & Chemical Corporation.

Borden Company plans to build a plant in The Phillippines, to produce urea resins. Construction of the new plant, a $750,000 plant to be located in Manila, will begin in March 1956. Initial production will run about 8 million pounds a year.

The British Petroleum Company, Ltd., will erect two new hydrofiners in Europe. One unit, with an 8000-barrel-a-day capacity, will go in at the company's refinery in Kent, England. The other, to be built for 5250 barrels a day, is scheduled for the refinery at Hamburg, Germany. Work on the two units is expected to start late this year.

Thunderbird Chemicals, Inc., is beginning construction on a $13-million fertilizer plant near Kyrene, Ariz. Plans for the installation were prepared by Ebasco Services, Inc. The plant, with the start of operations scheduled for mid-1956,

General American

offers you the best in

All types of Floating Roofs

WIGGINS HIDEK*

This is the natural design for storage of volatile products. A variable volume of vapor trapped beneath the steeply-pitched, quick-draining deck adds to its efficiency.

WIGGINS LODEK*

Designed so that the underside is in complete contact with the liquid surface. No vapor space can exist beneath the floating roof. Especially recommended where corrosive products are stored.

WIGGINS DOUBLEDEK*

If you prefer a double-deck roof choose the best—the new Wiggins Doubledek. Complete drainage design and between-deck accessibility add up to unmatched efficiency and safety.

WIGGINS FLOATING ROOFS PAY FOR THEMSELVES

Whatever your Floating Roof requirements get General American's UNBIASED analysis. Unbiased because General American makes ALL types of Floating Roofs!

Wiggins Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

*patented

WIGGINS VAPOR SEALS GENERAL AMERICAN TRADE MARK

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South La Salle Street • Chicago 90, Illinois

HYDRO-FLEX ■■■ we engineered this new steam trap for YOU!

☐ Install Strong Hydro-Flex steam traps with assured confidence. This completely new line of low, medium, and high pressure steam traps will operate equally well on light and heavy condensate loads.

Hydro-Flex offers these outstanding features and more:

- greater discharge capacity and efficient operation under *all* conditions
- dual fulcrum arrangement that snaps the leak-free valve wide open to give unrestricted condensate flow
- all working parts and deep-drawn bucket of durable stainless steel.
- rugged construction features assure long trouble-free service.

For complete information, contact your local Strong Distributor and write for new Bulletin No. SS-40A.

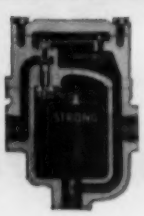
STRONG, CARLISLE & HAMMOND CO.
1392 W. 3RD. STREET
CLEVELAND 13, OHIO

STRONG®
HYDRO-FLEX high efficiency under all condensate loads
STEAM TRAPS

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.

BOTTOM INLET SERIES
Hydro-flex traps with bottom inlet have the same high qualities and features as horizontal types.

PRESSURE REGULATING VALVES
3 types available for wide range application . . . to meet pressure and capacity requirements.



BLAST TRAPS
Thermal types for quick air and condensate removal during rapid heating up.

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

Who's Building . . .

will manufacture anhydrous ammonia and such fertilizers as phosphates, sulphates and chemical urea.

The Pure Oil Company has started construction on its 12,000-barrel-a-day catalytic-reforming plant at Smiths Bluff, Texas. The new installation, an Ultraformer, is being installed by The Ralph M. Parsons Company. It is due to go on stream next spring.

Another unit will be added later to the company's Lemont, Ill., refinery. Pure now has one catalytic reformer, a 3000-barrel-a-day unit at its Newark, Ohio, refinery. This unit uses the Sinclair-Baker platinum catalyst and incorporates hydrogen treating of naphtha feed stock.

Commercial Solvents Corporation has completed its $5-million nitro-paraffin plant at Sterlington, La., and started production with an annual output of 5 million pounds. Chemical Construction Corporation and Ford, Bacon & Davis, Inc., held construction contracts. Engineering was handled by Tears Engineers and the staff.

Aviation Fuels, Inc., formed by C. F. Tears Engineers, will build a $24-million refinery at Beaumont, Texas, to make aviation gasoline and jet fuel. Construction is due to start early in 1956. A completion date has not been set. The plant is expected to turn out some 8000-barrels-a-day of aviation gasoline, plus jet fuel.

Standard Oil Company (Indiana) will install an Ultraformer as part replacement for the 55,000-barrel-a-day Hydroformer lost in the Whiting, Ind., fire. The new unit will be similar to the 12,600-barrel-a-day reformer being built at the company's Sugar Creek, Mo., refinery. Plans for other restoration projects at Whiting were still being formulated.

Petrosynthese, a new French company organized by Oronite Chemical Company and four French chemical and oil concerns, will build a plant to manufacture detergent alkylation. The new facilities will have an annual capacity for 24,000 tons of dodecylbenzene.

Southern Nitrogen Company plans to build a $14-million petrochemical plant at Savannah, Ga., with a daily capacity of 250 tons of ammonia which will be converted into nitrogen solutions and prilled ammonium nitrate. The new installation, the first synthetic-nitrogen plant in the south Atlantic states, will be in operation before the end of 1956.

Shell Chemical Corporation will build a 100-ton-a-day urea plant at Ventura, Calif. The plant, expected to be in operation by September 1956, will use ammonia and carbon dioxide from adjoining Shell plants as raw materials.

Southwestern Oil and Refining Company will install a 9000-barrel-a-day catalytic reformer at its refinery in Corpus Christi, Texas. The unit, a Platformer, is scheduled to go into operation early in 1956. A feature of the new facility will be a re-run column to produce selec-

Who's Building...

tive fractions of reformate with controlled boiling ranges to meet any future distillate requirements.

The Dow Chemical Company has started commercial production of polyethylene at its new $18-million plant at Freeport, Texas. The plant, started in May 1954, will be in full production this winter. Dow's plant uses a process licensed by Imperial Chemical Industries, Ltd., with refinements developed by its own engineers.

The company also is nearing completion on new facilities for an additional 60 million pounds a year of ethylene glycol and ethylene oxide.

Carbide and Carbon Chemicals Company will build additional vinyl-acetate production facilities at its Texas City, Texas, plant. The company, a division of Union Carbide and Carbon Corporation, expects to complete the project by fall 1956, more than doubling its present output.

Phillips Petroleum Company has awarded a contract for construction of new chemical-research laboratories, a sales service laboratory and a central power house at Bartlesville, Okla. The units will be built by Manhatten Construction Company.

The Bay Petroleum Corporation, recently purchased by Tennessee Gas Transmission Company, will expand its 18,000-barrel-a-day Chalmette, La., refinery to a daily capacity of 26,000 barrels. The project, due for completion in May 1956, is expected to cost $1.5 million.

Mid-South Chemical Corporation will build an anhydrous-ammonia plant at Lake Charles, La., where raw materials will be finished by the Continental Oil Company and Cities Service Company. The two companies recently acquired an interest in Mid-South Chemical.

Imperial Oil, Ltd., has completed its $13-million lubricating oil plant at Edmonton, Alba. The new installation, built by Canadian Kellogg Company, will turn out 2000 barrels a day.

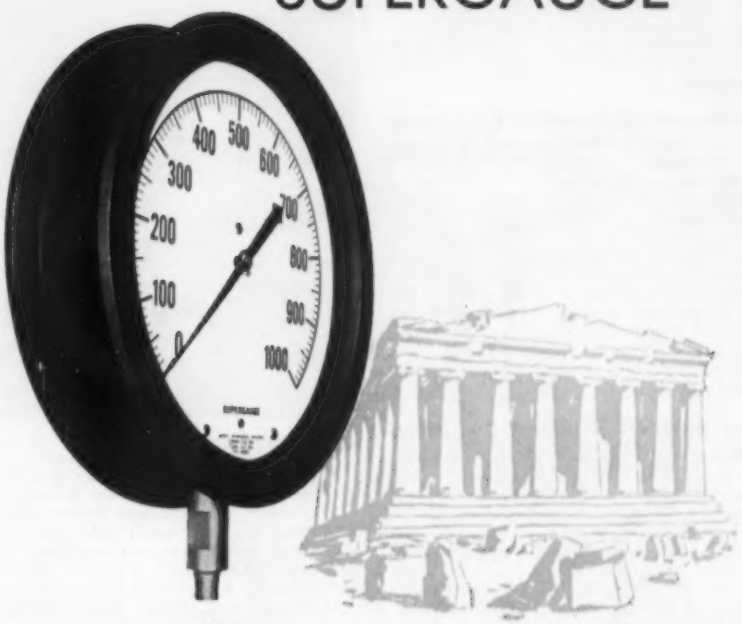
Polymer Corporation is planning a 7000-ton-a-year addition to its synthetic-rubber facilities at Sarnia, Ont.

Husky Oil & Refining Company has opened its expanded Moose Jaw, Sask., refinery, marking completion of a modernization program which more than doubled the plant's daily capacity and boosted the company's total refining capacity to 15,500 barrels.

Additions to the refinery, giving it a 3000-barrel-a-day capacity, include a platinum reformer, a diesel-desulphurization plant, an asphalt unit and a visbreaker, together with enlarged storage capacity and other equipment.

Husky also recently completed expansions of refineries at Lloydminster, Alba., and Fort William, Ont. Since the Fort William and Moose Jaw refineries were acquired in 1954, the company has spent

the NEW USG SUPERGAUGE®



...built to last a lifetime!

With proper application, the new USG Supergauge will last a lifetime!

SEGMENT—stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

MONO-UNIT CONSTRUCTION—permits easy removal of complete gauge assembly for inspection and adjustment.

ARC-LOC MOVEMENT—permits all calibration adjustments of gauge assembly from rear without removing dial and pointer.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

These features are also available in USG Solfrunt Gauges with solid front construction.

Supergauges available in 4½", 6", and 8½" sizes. For complete information on case styles, materials of construction and connections write for Publication 1819.

USG UNITED STATES GAUGE

Gauge Headquarters FOR OVER 50 YEARS

United States Gauge, Division of American Machine & Metals, Inc., 104 Clymer Avenue, Sellersville, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building...

more than $5.5 million for expansion of refining and other facilities.

Construction on the Moose Jaw project was handled by The Fluor Corporation, Ltd., which also was in charge of engineering. Reforming equipment was installed under license with The Atlantic Refining Company.

Richmond Exploration Company plans to build a $4-million asphalt refinery at Maracaibo, Venezuela. The company, a subsidiary of Standard Oil Company of California, has designed the plant for a daily capacity of 10,000 barrels. Construction, approved by the Venezuelan government, was to be started immediately, with completion scheduled for August, 1956.

Principal component of the refinery will be a two-stage distillation unit, operating on 10.5 degree Boscan crude oil. Auxiliary structures will include a boiler plant and smaller office, shop and laboratory buildings.

The British Petroleum Company, Ltd., will start construction late this year on a LPG-bottling plant at its recently-completed Kwinana refinery in western Australia. The plant will fill 32-pound, 100-pound and one-ton containers, and include a filling point for loading bulk vehicles.

Also at Kwinana, the company has started production at a new bitumen plant. Installed at the government's request, the plant will turn out about 2000 tons of bitumen a year.

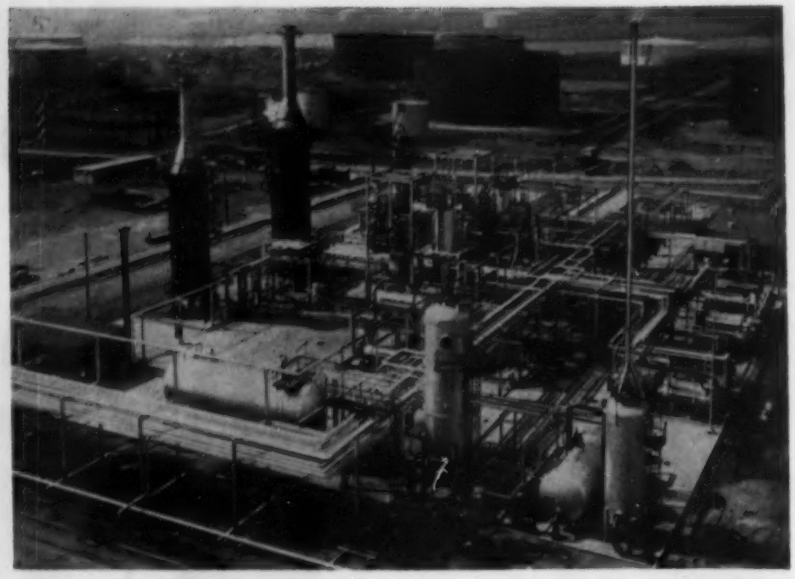
Government of South Africa, planning an industrial-expansion program in northern and eastern Transvaal, is considering construction of an oil-from-coal plant similar to the coal hydrogenation facility recently completed at Sasolberg in Orange Free State.

The British American Oil Company, Ltd., is processing on schedule with construction of a 13,000-barrel-a-day catalytic reforming unit at its Montreal East refinery. The new unit, expected to cost some $3 million, will go on stream late this year. The Lummus Company is in charge of both engineering and construction.

Atlas Processing Company has gone on stream with its second Platforming unit at Shreveport, La. This newest unit, built for a daily capacity of 3500 barrels, will produce 94 leaded octane blending compound. The earlier unit has a 4400-barrel-a-day capacity.

Standard Oil Company of California is building a $7-million isophthalicanhydride plant at Richmond, Calif. The new facility, designed to turn out 50 million pounds of the product a year, will be completed late in 1955. H. K. Ferguson Company is contractor.

McColl-Frontenac Oil Company, Ltd., has gone on stream with a combination Platformer-Unifiner at its refinery near Montreal, Queb. The new unit has an 11,970-barrel-a-day capacity, with the Unifiner serving as feed-preparation unit for the Platformer.



New Units Boost Quality—

These two new Hydrofiners are used to improve the quality of cracked distillates at Esso Standard Oil Company's Bayway Refinery at Linden, N. J. Designed and built by C. F. Braun and Company, the units have replaced the plant's acid-treating and rerunning of naphtha and heating-oil streams. Product yield on the Bayway units is 100 percent, in contrast to the low yield from acid-treating and rerunning. The two units stand side by side on a common plot. One treats 7640 barrels a day of 44 API-gravity cracked naphtha, while the other charges 19,520 barrels a day of 24 API-gravity cracked heating oil. After hydrogenation in a reactor, each stream goes through heat exchange and a stripper-column, then to a caustic wash.

American Oil Company is building a delayed coker unit at its Yorktown, Va., refinery, to convert heavy residuals from crude and from cracking distillates to coke and intermediate type distillates suitable for thermal or catalytic cracking to motor fuel.

J. M. Huber Corporation plans to a new unit which will increase furnace black production at its Borger, Texas, plant by 20 or 30 million pounds a year. The new addition will represent a 15-percent expansion of the company's furnace-black capacity. It now has four units in operation at Borger and two at Eldon, Texas, as well as another plant at Borger. The new unit is due to go into operation late in 1956.

Shell Chemical Company has completed construction of facilities at its Norco, La., plant, to make allyl chloride and chlorohydrins. The next unit to be built at Norco will be a hydrogen-peroxide plant. A second plant, to be built later, will make acrolein, while a third new unit will produce synthetic glycerine, using acrolein and hydrogen peroxide as intermediates.

The new plants will use processes developed by Shell Development Company, which also originated the earlier process for making glycerine from petroleum. This process is in use at the Shell plant in Deer Park, near Houston, where a fourth of the U. S. consumption of glycerine is produced.

Phillips Petroleum Company will expand by 20 percent the capacity of the lubricating-oil plant at its Kansas City, Kan., refinery. The expansion will be the plant's second since it was built in 1949.

Amazonia Petroleum Company, building a 5000-barrel-a-day refinery near Manaus, expects to bring the new Brazilian plant on stream sometime in early 1956. The company has received about 90 percent of the equipment for the plant. Southwestern Engineering Company has charge of engineering and construction on the $4,500,000 refinery.

Stauffer Chemical Company plans to build a new petrochemical plant at Louisville, Ky., for the production of carbon tetrachloride, chloroform, methylene chloride and anhydrous hydrogen chloride. Structural and process engineering are underway. Construction will start early in 1956, with completion scheduled for 1957.

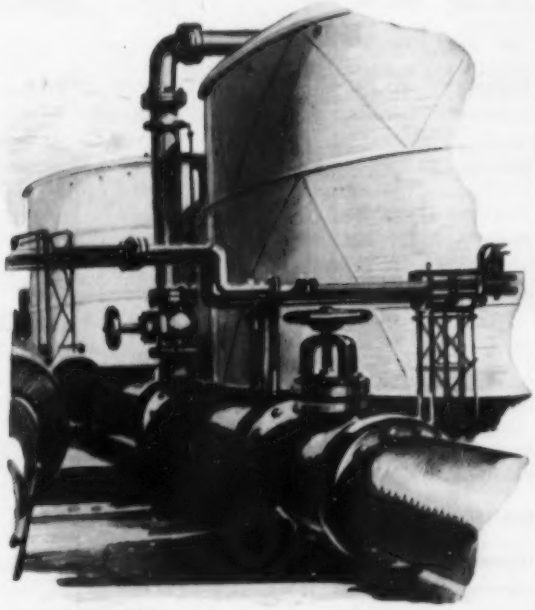
Bankline Oil Company, planning to build a fluid coker and catalytic reformer at its refinery in Bakersfield, Calif., has awarded The Fluor Corporation, Ltd., a contract to engineer and construct the coking unit. The unit, a 4000-barrel-a-day installation licensed by Esso Research & Engineering Company, is scheduled for completion late in 1956.

The additions are part of a $4-million modernization program, which also includes the conversion of existing hydrofluoric-acid alkylation facilities into a sulfuric-alkylation plant. The coking unit will convert topped crude and thermally-cracked fuel oil to gasoline, gas-oil, gas and petroleum coke. The gas-oil product will be used as charge stock to the refinery's existing thermal-cracking unit.

Standard Oil Company (Indiana) will build an Ultraforming unit at its refinery in Whiting, Ind., as soon as the site can be cleared. The new 14,000-

"Klingerise" -economise!

As a result of their outstanding characteristics "Klingerflow" Seatless Piston Valves are most economical in use. They operate on an entirely different principle from the usual type of seating valve. The valve consists basically of a finely ground piston, operated by the valve spindle and handwheel and moving through two or three non-metallic resilient valve rings, capable of resisting oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush.



"Klingerflow" Valves are made in a great variety of designs and sizes, to suit all purposes, and have the following outstanding advantages :-

No seat — consequently no regrinding.

Can be serviced in the line.

Unaffected by wiredrawing.

Unaffected by throttled use.

INSTALL KLINGER SEATLESS PISTON VALVES

Write for the Klinger Master Catalog which describes the complete range of Klinger products.

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

Cables: Klingerit — **Agents throughout the world** — **Telephone: Foots Cray 3022**

Manufacturing Licensees for Canada

JOSEPH ROBB & COMPANY, LIMITED
5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone WILBANK 3181 — Cable ROBCL
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER QUEBEC CITY.

Manufacturing Licensees for U.S.A.

THE KLINGER CORPORATION OF AMERICA
95, RIVER STREET, HOBOKEN, NEW JERSEY, U.S.A.
Telephone HOBOKEN 2-7915 — Cable: KLINGDALE

Distributors and Agents in principal cities.

MANUFACTURERS OF KLINGER SEATLESS PISTON VALVES; KLINGER SLEEVE-PACKED COCKS; KLINGER LEVEL INDICATORS; RINGS AND SEALS IN KLINGER SYNTHETIC MATERIALS, AND KLINGERIT COMPRESSED ASBESTOS SHEET JOINTINGS AND PACKINGS FOR EVERY PURPOSE

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

barrel-a-day unit, originally scheduled for construction in 1957, will be installed by The Ralph M. Parsons Company.

Parsons also is building a duplicate unit at Standard's Sugar Creek, Mo., refinery. The duplication will be made to step up construction by eliminating the usual preliminary delays required for detailed engineering.

The new unit will supplement a fixed-bed Hydroformer, built during World War II, using a molybdena catalyst. The refinery's other catalytic-reforming unit is the fluid Hydroformer damaged by explosion and fire. The plant's two large catalytic-cracking units received no significant damage during the August fire.

The new reformer highlights a revamping of the refinery's plans for immediate and long-range construction. The program, which calls for rebuilding or replacing the 50,000-barrel-a-day damaged fluid Hydroformer, also includes:

- Repairing and rebuilding pumphouses and equipment in the damaged area. This work is well underway and some of the repaired equipment already has been returned to service.
- Building new tanks, including a new field of 20 tanks, to replace some of the 70-odd burned-out tanks. The new tank field is being prepared.
- Rearranging the use of undamaged tanks, where practical, to let essential operations continue while the new tanks are being built. The program, well underway, has permitted crude-running operations to be resumed at a rate of 100,000 barrels a day and is due to be further accelerated.

The renovation or replacement of the plant's fluid Hydroformer is figured late in the company's overall program for Whiting. A decision regarding the unit will be made after engineers have inspected the remaining usable parts and evaluated alternate possibilities.

Societa per Azioni Raffineria Olii Minerali will build Europe's first Iso-Plus Houdriforming unit at Ravenna, Italy. The new 4000-barrel-a-day installation, scheduled to go on stream in June, 1956, will couple regular Houdriforming and supplemental thermal reforming in the processing of naphthas from Iraq crude.

Engineering will be handled by Houdry Process Corporation and The Lummus Company, and construction will be carried out by Breda Electromaconia Locomotive, a Milan firm. The thermal-reforming facilities already are in existence at SAROM's 35,000-barrel-a-day Ravenna refinery.

Construction Boxscore: Refineries and Other Plants . . .

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chemical & Dye Corp.	Moundsville, W. Va.	Hydrogen & Carbon Monoxide Plt.	.....	.....	Under Constr.	Jan., 1956	.....	Girdler	Girdler
*Ashland Oil & Refining Co.	Catlettsburg, Ky.	Add Crude Unit	1600 bbls.	.....	Under Constr.	Early 1956	.....	.....	.....
		Cat. Cracker	32,000 bbls.	.....	Planning	Early 1956	.....	.....	.....
Proctor & Gamble Mfg. Co.	Chicago, Ill.	Hydrogen Plt.	.....	.....	Engineering	May, 1956	.....	Girdler	Girdler
American Oil Co.	Yorktown, Va.	Refinery	35,000 bbls.	$25,000,000	Under Constr.	Late, 1956	.....	Kellogg, Lummus	Kellogg, Lummus
Ashland Oil & Refining Co.	Catlettsburg, Ky.	Houdriformer	6,000 bbls.	.....	Complete	.....	Houdry	Cat. Constr.	Cat. Constr.
Atlantic Refining	Philadelphia	Jet-fuel Blending	.....	$450,000	ODM Approved	.....	.....	.....	.....
California Oil Co.	Perth Amboy, N.J.	Crude Desalter	30,000 bbls.	$125,000	Complete	.....	Howe-Baker	.....	.....
Columbia-Southern Chemical Corp.	Natrium, W. Va.	Anhydrous Ammonia Plt.	.....	$3,000,000	Under Constr.	April, 1955	.....	.....	.....
Commerce Oil Ref.	Portsmouth, R.I.	Refinery,	30,000 bbls.	$30,000,000	Planning	Early, 1957	.....	Lummus	.....
		Cat. Cracking	25,000 bbls.						
		Crude Units	40,000 bbls.						
*Cons. Chem Ind.	Le Moyne, Ala	Sulfuric Acid Plt.	.....	$2,000,000	.....	Mid 1956	.....	.....	.....
*E. F. Drew & Co.	Boonton, N. J.	Exp. Hydrogen Plt.	.....	.....	Completing	.....	.....	Girdler	Girdler
Du Pont	Parlin, N.J.	Polyester Film Base	.....	.....	.....	.....	.....	.....	.....
Du Pont	Parkersburg, W. Va.	Tetrafluoroethylene Expan.	.....	.....	.....	.....	.....	.....	.....
Du Pont	Niagara Falls, N.Y.	Adiponitrile Unit Expans.	.....	.....	.....	.....	.....	.....	.....
Du Pont	Louisville, Ky.	Inc. Fluorinated Hydrocarbon Capacity	.....	.....	Completing	4th Qtr., 1955	.....	.....	.....
Elk Refining	Falling Rock, W. Va.	Unifiner	1,000 bbl.	$150,000	Complete	.....	U.O.P.	.....	Staff
Escambia Bay Chemical Corp.	Pensacola, Fla.	Ammonia, Nitrogenous Fertiliser Plt.	.....	$25,000,000	Under Constr.	Early 1956	.....	.....	Chemico
Esso Standard Oil Co.	Linden, N.J.	Convert Blending Syst. to Semi-Automatic	.....	$2,120,000	Under Constr.	1st Qtr., 1956	Esso R&E	Esso R&E	Staff
*Esso Standard	Linden, N. J.	Fluid Hydroformer	20,000 bbls.	.....	Planning	3rd Qtr. 1956	Esso R&E	.....	.....
Esso Standard	Bayonne, N.J.	Add. Dewaxing Capacity	.....	.....	Engineering	1st Qtr., 1956	.....	Esso R&E	.....
Esso Standard Oil Co.	Everett, Mass.	Desalters	25,000 bbls.	$612,000	Under Constr.	4th Qtr., 1955	.....	Esso R&E	Petrolite
B. F. Goodrich	Calvert City, Ky.	Chemical Plt.	.....	$8,500,000	Complete	.....	.....	Fluor	Fluor
B. F. Goodrich	Shelton, Conn.	Carbon Dioxide Plt.	25 tons	.....	Complete		.....	Girdler	Girdler
B. F. Goodrich	Louisville, Ky.	Syn. Rubber	.....	$2,500,000	Under Constr.	1st Qtr., 1956	.....	Staff, Girdler	Girdler
*Kentucky Hydrocarbon	Maytown, Ky.	Ethane Plt.	50 Mmcf	.....	Designing	Early 1957	.....	.....	.....
Ketona Chemical	Tarrant, Ala.	Ammonia Nitrate of Ammonia Plt.	.....	.....	Planning	1956	.....	Fluor	Fluor
Miami Oil & Refining Co.	West Palm Beach, Fla.	Refinery	15,000 bbls.	$12,000,000	Planning	.....	.....	.....	.....
Monsanto Chemical	Springfield, Mass.	Polyvinyl Chloride Resins Plt.	25,000,000 lbs./yr.	$2,040,000	Planning	1st Qtr., 1956	.....	Staff	.....
		Nitric Acid Plt.	60 ton/yr.	.....	Planning	1956	.....	Fluor	Fluor
Northern Chemical Industries	Searsport, Me.	Ammonia	125 tons	$9,000,000	Under Constr.	2nd Qtr., 1956	Texaco	Girdler	Girdler
		Nitric Acid	60 tons		Under Constr.	.....	Du Pont	Girdler	Girdler
		Nitrogen	.....		Under Constr.	.....	.....	Girdler	Girdler
Northern Chemical	Searsport, Me.	Sulfuric Acid Plt.	100 tons	.....	Planning	Jan., 1956	.....	.....	.....
The Pencoil Co.	Rousseville, Pa.	Platformer-Unifining	.....	.....	Considering	.....	U.O.P.	.....	.....
Pontiac Eastern Corp.	Lumberton, Miss.	Refinery	12,000 bbls.	$10,000,000	Planning	.....	.....	Fluor	Fluor
Seminole Oil	Fort Pierce, Fla.	Refinery	15,000 bbls.	$16,000,000	Planning	Aug., 1956	U.O.P.	Ebasco	.....
Sinclair Refining Co.	MarcusHook, Pa.	Crude Stills	120,000 gals.	$12,700,000	Under Constr.	May, 1956	.....	Parsons	Parsons
Sinclair Refining	Marcus Hook, Pa.	Desulfurization	10,000 bbls.	$3,500,000	Under Constr.	Jan., 1956	.....	Parsons	Parsons
Socony-Mobil	Paulsboro, N.J.	Sovaformer	20,000 bbls.	.....	Under Constr.	March, 1956	.....	Fluor	Fluor

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Socony Mobil	Brooklyn	Sovaformer			Engineering	Oct, 1956		Bechtel	Bechtel
*Socony Mobil	Buffalo, N. Y.	Gaso. Trtg.			Under Constr.	Nov. 1955		Badger	Badger
*Socony Mobil	Buffalo, N. Y.	Sovaformer	9,000 bbls.		Engineering	May, 1956		McKee	McKee
*Southern Nitrogen	Savannah, Ga.	Ammonia Plt.	250 ton		Under Constr.	Late 1956			
Spencer Chemical	Vicksburg, Miss.	Addl. Nitrogen		$1,500,000	Under Constr.	Early, 1956		Staff	Quaker
Stauffer Chemical	Mobile, Ala.	Carbon Bisulfide Plt.			Planning	Spring, 1956			
Sun Oil Co.	Marcus Hook, Pa.	Ammonia Plt.	300 tons	$9,000,000	Under Constr.	Nov., 1955		Cat. Constr.	Cat. Constr.
*Tennessee Eastman	Kingsport, Tenn.	Hydrogen Plt.			Under Constr.	Early 1956		Girdler	Bay Mtn., Staff
Tennessee Gas Transmission	Isola, Miss.	Compressor Sta.	5500 HP.		Under Constr.	July, 1955		Staff	Olsen
*Thompson Chem.	North Dighton, Mass.	Polyvinyl Chloride Plt.			Planning		SDC	SDC	
Tide Water Associated Oil	Wilmington, Del.	Refinery	130,000 bbls.	$100,000,000	Under Constr.	End, 1956		Braun, Kellogg	
Union Carbide & Carbon Corp.	Leaksville, N.C.	Dynel Fiber Plt.		$30,000,000	Planning	1955		Staff	
Union Carbide & Carbon	Niagara Falls, N.Y.	Research Lab.		$1,957,229	ODM Cert.				
Westvaco Chlor-Alkali Div.	South Charleston W. Va.	Anhydrous Ammonia Plt.	60 tons			Late 1955			Lummus
MID-CONTINENT									
Amerada Pet. Corp.	Williston Basin, N.D.	Natural Gasoline Plt.		$10,000,000	Planning				
*Anderson-Prichard	Arkansas City, Kans.	Platformer	5000 bbls.		Complete		UOP	Sweco	Sweco
*Ashland O&R	Findlay, Ohio	Reformer	3000 bbls.		Planning	Early 1956			
		Hydrogenation	4000 bbls.		Planning	Early 1956			
Atlas Powder Co.	Site Undetermined	Ammonia Plt.		$6,750,000	ODM Certified				
Atlas Powder Co.	Site Undetermined	Glycerin Plt.		$5,940,000	ODM Certified				
*Aurora Gasoline	Detroit	Rexformer	5500 bbls.	Part of	Under Constr.	Early 1956	UOP	UOP	Staff
		Unifiner	7500 bbls.	$5,000,000	Under Constr.	Late 1955	UOP	UOP	Parsons
		Fluid Coker	4000 bbls.	Project	Under Constr.	Spring, 1955	Esso R&E	Parsons	Parsons
Calumet Nitrogen Products Co.	Hammond, Ind.	Ammonia Nitrogen Fertilizer	300 Tons		Under Constr.	May, 1956		Fluor	Fluor
Champlin Refining Co.	Enid, Okla.	Expansion:							
		Fluid Cat. Crker.	9,000 bbls.	$4,000,000	Under Constr.	Nov, 1955	Kellogg		Kellogg
		Platformer	5,000 bbls.		Complete		U.O.P.		Sweco
*Cities Service	Ponca City, Okla.	Rexformer	6,000 bbls.		Engineering	Jan., 1957	UOP	UOP	Procon
*Cities Service	Wichita, Kans.	Revamp Gaso. Plt.				Spring, 1956			
Cities Service Oil	Ponca City, Okla.	Increase Ref.	10,000 bbls.	$2,000,000	Engineering				
*Clark O&R	Chicago	Reformer, Topping Unit.			Completing				
Commercial Solvents Corp.	Peoria, Ill.	Enlarge Nitroparaffin Derivatives Fac.		Part of $5,000,000	Planned				
*Consumers Co-op	Coffeyville, Kans.	Platformer	5000 bbls.	$250,000	Planning	Mid 1956	UOP		
		Unifiner	3000 bbls.		Planning	Mid 1956	UOP		
		Delayed Coker	7000 bbls.		Planning	Mid 1956	UOP		
Continental Oil	Ponca City	Dairy-Wax Plt.	11,000,000 lbs./yr.	$500,000	Planning	Early, 1956			
*Derby Oil	Wichita, Kans.	Ultraformer	2500 bbls.	Part of $700,000	Under Constr.	July, 1956	Standard-Ind.		Pritchard
Du Pont	Montague, Mich.	Neoprene Plt.			Planned	4th Qtr., 1956			
*DX-Sunray	Duncan, Okla.	Expan. Cat. Cracking	5000 bbls.	$250,000	Planning				
DX-Sunray	West Tulsa, Okla.	Expand Cat. Cracking	†3500	$300,000	Complete			Staff	Staff
D-X Sunray	Tulsa	Delayed Coking	7,000 bbls.	$2,500,000	Under Constr.	Nov., 1955		Kellogg	Kellogg
El Dorado Refining	El Dorado, Kan.	Cat. Reformer	2,500 bbls.		Planning		U.O.P.		
Firestone Tire	Akron, Ohio	Expand Syn. Rubber Plt.	†35 percent		Planning				
*Goodrich-Gulf	Avon Lake, Ohio	Synthetic Rubber Pilot Plt.			Planning				
Great Plains Refinery Development Co.	Rapid City, S.D.	Refinery	3,000 bbls.	$3,100,000	Under Constr.	End, 1955		Succop	Succop
Great Northern Oil Company	Pine Bend, St. Paul, Minn.	Crude Topping	25,000 bbls.					Fluor	Fluor
		TCC Unit	12,000 bbls.				Soc-Vac.	Fluor	Fluor
		Ultraformer	5,000 bbls.				Indiana-Standard	Fluor	Fluor
		Add. Crude Unit	5,000 bbls.						
		Hydrodesulfurizer	11,000 bbls.	$25,000,000	Complete		Indiana-Standard	Fluor	Fluor
		Cat. Poly.	900 bbls.				U.O.P.	Fluor	Fluor
		Delayed Coker	450 tons					Fluor	Fluor
*Hercules Powder	Louisiana, Mo.	Formaldehyde Plt.	100,000,000 lbs./yr.		Under Constr.	Late 1956			
		Pentaerythretol Plt.	24,000,000 lbs./yr.		Under Constr.	Late 1956			
International Refineries	Wrenchall, Minn.	Petroleum Refining Fac.		$9,500,000	ODM Approved				
Kimball Gas Products	Kimball City, Neb.	Gasoline Plt.	7.5 Mmcf	$1,000,000	Complete			Olsen	Olsen
Leonard Refineries	Alma, Mich.	Ultraformer	3,600 bbls.		Planning			Parsons	Parsons
		Hydrofiner	5,200 bbls.		Planning			Pritchard	Pritchard
*Midland Co-op.	Cushing, Okla.	Platformer	3000 bbls.	$650,000	Under Constr.	April, 1956	UOP	UOP	Procon
Mississippi River Chemical	Selma, Mo.	Ammonia Plt & Nitrates	200 tons	$15,000,000	Complete		Texaco Dev.	Fluor	Fluor
Naph-Sol Refining Co.	Muskegon, Mich.	Cat. Reformer	6,000 bbls.		Planned				
*National Co-operatives	McPherson, Kans.	Alkylation	1400 bbls.		Planning		UOP		
National Distillers	Tuscola, Ill.	Natural Gas Reforming Plt.			Complete			Girdler	Girdler
National Petro-Chemicals	Tuscola, Ill.	Polyethylene Facilities	25 million lbs./year		Complete		I.C.I.	Kellogg	Kellogg
Northwestern Refining	St. Paul Park, Minn.	Cat. Reformer	6,000 bbls.		Planning	May, 1956			
Olin Mathieson	Olin, Ind.	Cellophane Plt.				1956			
Pana Refining Co.	Pana, Ill.	Modernization	†1,600 bbls.	$900,000					
Pana Refining	Pana, Ill.	Girbotol Unit			Under Constr.				Parker
Phillips Petroleum	Kansas City, Kansas	Catalytic Reformer	16,000 bbls.	$5,400,000	Under Constr.	Spring, 1956	U.O.P.	Procon Phillips	Procon
Phillips Petroleum & Magnolia Petro.	Linsay, Okla.	Nat. Gasoline			Under Constr.	1956		Phillips	Phillips
Prime Oil Co.	Calumet City, Ill.	Refinery	15,000 bbls.	$10,000,000	Planned				
The Pure Oil Co.	Lemont, Ill.	Cat. Reformer			Planning				

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*R&J O&R	Princeton, Ind.	Thermal Poly	1800 bbls.	.....	Planning	.....	.....	UOP	.....
Sinclair Refining Co.	E. Chicago, Ind.	Cat. Cracking Expan.	.....	$2,252,000	ODM Cert.	.....	.....	.....	.....
Sinclair Refining	East Chicago, Ind.	Carbon-Monoxide Boiler	†30,000 bbls.	.....	Complete	.....	.....	B & W	B & W
		Crude Unit	.....	.....	Planning	May, 1956	.....	.....	.....
*Socony Mobil	E. Chicago, Ind.	Sovaformer	.....	.....	Under Constr.	Dec., 1956	.....	Braun	Braun
*Socony Mobil	Trenton, Mich.	Sovaformer	.....	.....	Engineering	April, 1956	.....	Bechtel	Bechtel
Socony Mobil	East Chicago, Ind.	Alkylation	.....	.....	Planning	Feb., 1956	.....	Kellogg	Braun
		Crude Unit	*30,000 bbls.	.....	Under Constr.	May, 1956	.....	.....	.....
*Standard-Indiana	Whiting, Ind.	Ultraformer	14,000 bbls.	.....	.....	.....	Standard-Ind.	Parsons	Parsons
Standard-Indiana	Whiting, Ind.	Heavy Oils Modern.	.....	.....	Under Constr.	Early, 1956	.....	.....	Foster Wheeler
Standard-Indiana	Whiting, Ind.	Crude Unit	55,000 bbls.	.....	Under Constr.	Early, 1956	.....	.....	Braun
Standard-Indiana	Wood River, Ill.	Coking Unit	8,500 bbls.	.....	Planning	1957	.....	.....	.....
Standard-Indiana	Mandan, N. D.	Ultraformer	5,400 bbls.	.....	Engineering	Late 1956	Standard-Ind.	.....	Parsons
Standard-Indiana	Sugar Creek, Mo.	Ultraformer	12,600 bbls.	.....	Under Constr.	Late, 1955	Standard-Ind.	.....	Parsons
Standard (Ohio)	Lima, Ohio	Cat. Polymerization Unit	.....	$335,000	Complete	.....	.....	.....	.....
Standard (Ohio)	Lima, Ohio	Petrochemical Plt: Anhydrous Ammonia	300 tons	$17,000,000	Under Constr.	Nov., 1955	.....	.....	Kellogg
		Nitric Acid	180 tons						
		Nitrogen Solution	200 tons						
		Offsite Fac.	.....	.....	.....	.....	.....	.....	McKee
		Urea Plt.	120 tons	.....	Under Constr.	Jan., 1956	Vulcan	Vulcan	Vulcan
*Standard (Ohio)	Lima, Ohio	Dry-Ice Plt.	75 tons	$800,000	Planning	Spring, 1956	.....	.....	.....
Standard (Ohio)	Cleveland, Ohio	Ultraformer	11,000 bbls.	$4,400,000	Engineering	2nd Qtr., 1956	Standard-Ind.	Fluor	Fluor
St. Paul Ammonia Products Co.	Pine Bend, Minn.	Ammonia Plt.	200 tons	$15,000,000	Planning	April, 1956	.....	.....	.....
*Sunray-Midcontinent	Moore, Okla	Exp. Gaso. Plt.	.....	$275,000	Planning	May, 1956	.....	Staff	.....
The Texas Co.	Tulsa, Okla.	Platformer Unit	9,040 bbls.	.....	Complete	.....	.....	U.O.P., Refinery	Refinery & Others
The Texas Co.	Lockport, Ill.	Platformer	10,854 bbls.	.....	Complete	.....	.....	U.O.P. and McKee	McKee
The Texas Co.	Lockport, Ill.	Alkylation Plt.	1,000 bbls.	.....	Under Constr.	1st Qtr., 1956	.....	Staff	.....
*Vickers Petroleum	Potwin, Kans.	Reformer	.....	.....	Planning	.....	.....	.....	.....
		Cat. Poly	.....	.....	Planning	.....	.....	.....	.....
Wisconsin Oil Refining Co.	Sheboygan, Wis.	Vacuum Unit	2,500 bbls.	.....	Planning	.....	.....	Koch	.....
SOUTHWEST									
American Republics Corp., et al	Silsbee, Texas	Gaso. Plt.	20 Mmcf	$1,000,000	Under Constr.	Aug., 1955	.....	Braun	Olsen
Atlantic Refining	Atreco, Texas	Increase Alkyl.	.....	.....	Complete	.....	.....	.....	.....
		Water Treating	.....	.....	Complete	.....	.....	.....	.....
Arkansas Fuel Oil	Panola County, Texas	Cat. Reformer	1,800 bbls.	.....	Engineering	.....	.....	.....	.....
*Aviation Fuels	Beaumont, Tex.	Refinery	.....	$24,070,000	.....	ODM Approved	.....	.....	.....
*Bureau-Mines	Exell, Texas	Helium Plt.	.....	$6,000,000	Planning	.....	.....	Stearns-Rogers Bureau-Mines	.....
*Bay Petroleum	Chalmette, La.	Ref. Expan.	.....	$1,850,000	Planning	May, 1956	UOP	.....	.....
Celanese	Pampa, Texas	Increase Vinyl-Acetate Facl. Methyl Ethyl Unit	.....	.....	Complete	.....	.....	.....	.....
Cities Service, et al	Seminole, Texas	Nat. Gas Plt.	55,000 gals.	.....	Planning	1956	.....	.....	Delta
Cities Service et al	Midland, Texas	Nat. Gaso. Plt.	.....	.....	Engineering	.....	.....	.....	.....
Columbian Carbon Co.	North Bend, La.	Carbon Black Plt.	60,000,000 lbs./yr.	.....	Under Constr.	Nov., 1955	.....	.....	.....
Commercial Solvents Corp.	Sterlington, La.	Nitroparaffins Fac.	10,000,000 lbs./yr.	$5,000,000 (Incl. Peoria, Ill.)	Complete	.....	.....	Staff & Tears	Ford, Bacon & Davis
*Cosden Pet.	Bay Spring, Tex.	Reformer	3900 bbls.	$2,500,000	Under Constr.	May, 1956	UOP	Procon	Procon
		Revamp Cat. Cracker	13,000 bbls.	$1,000,000	Under Constr.	Jan., 1957	UOP	Cosden	Cosden
		Unifiner	2100 bbls.	$137,000	Under Constr.	Nov., 1955	UOP	Cosden	Cosden
		Styrene Plt.	.....	.....	Planning	Fall., 1956	.....	Badger	Badger
Corpus Christi Refining Co.	Tucker, Texas	Modernization	.....	.....	Planned	.....	.....	.....	.....
Dow Chemical Co.	Velasco, Texas	Glycerin Unit, Polyethylene	36,000,000 lbs./yr.	$18-20,000,000	Complete	.....	.....	.....	.....
Dow Chemical Co.	Freeport, Texas	Soda Ash Plt.	300 tons	$3,000,000	Complete	Oct., 1955	.....	.....	.....
Eastern States Petroleum Co.	Houston, Texas	Coking Plt.	13,000 bbls.	$4,000,000	Projected	.....	.....	.....	.....
D. D. Feldman Co.	Lake Arthur, La.	Petrochem. Plt.	.....	$843,000	Applied for certificate of necessity	.....	.....	.....	.....
Firestone Tire	Lake Charles, La.	Expand Synth. Rubber Plt.	.....	.....	.....	.....	.....	.....	.....
Goodyear Synthetic Rubber	Houston	Copolymer Expansion	†50%	$750,000	Planning	.....	.....	.....	.....
Gulf Oil	Port Arthur, Texas	Two Gulfiners	20,000 bbls. Each	.....	Building	.....	Gulf	Gulf, Kellogg	Kellogg
*Gulf Oil	Pt. Arthur, Tex.	Inc. Ethylene Fac.	.....	.....	Considering	.....	.....	.....	.....
Gulf Oil	Port Arthur Texas	Crude Topping	100,000 bbls.	.....	Under Constr.	Spring, 1956	.....	McKee-Gulf	McKee
		Catalytic Cracking Unit	68,500 bbls.	.....	Under Constr.	Spring, 1956	.....	Kellogg	Kellogg
*Humble	Ironton, Texas	Gasoline Plt.	11 Mmcf	.....	Under Constr.	Late 9955	.....	.....	.....
Humble Oil & Refining Co.	Baytown, Texas	Hydroformer No. 1	18,000 bbls.	$4,000,000	Complete	.....	.....	Fluor	Fluor
*Jefferson Lake Sulphur	Mary Parish, La.	Gasoline Plt.	40 Mmcf	.....	Under Constr.	.....	.....	.....	.....
*Magnolia	Beaumont, Tex.	TCC Unit	2800 bbls.	.....	.....	.....	.....	.....	.....
		Sovaformer	20,000 bbls.	$25,000,000	.....	Fall, 1956	.....	.....	.....
		Vacuum Flash Tower	.....	.....	.....	.....	.....	.....	.....
McBride Refining Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	$2,500,000	Planned	.....	.....	.....	.....
McMurrey Refining Co.	Tyler, Texas	Avia. Gaso. Plt.	.....	$3,000,000	Complete	.....	.....	Blaw-Knox, Kellogg	Blaw-Knox
*MidSouth Chemical	Lake Charles, La.	Ammonia Plt.	.....	.....	Planning	.....	.....	.....	.....
North American Petro.	Corpus Christi, Texas	Refinery	.....	$1,000,000	Under Constr.	Late, 1955	Atlantic	.....	.....
		Cat. Reformer	2,000 bbls.	.....	.....	.....	.....	.....	.....
Northeast Texas Chemical Co.	East Texas	Chemical and Fertilizer Plt.	.....	.....	Planning	.....	.....	Tears	Beck
*Odessa Natural Gasoline	Ector County Texas	Nat. Gaso. Plt. Expansion	†40 Mmcf	$1,600,000	Complete	.....	.....	.....	Bowden

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Petro-Tex Chemical	Houston	Butadiene Expansion	†45,000 tons/yr.	$1,000,000	Planning				
Phillips Petroleum Co.	Phillips, Texas	Distillate Hydrogenation Unit	10,000 bbls.	$488,000	Complete			Procon	Procon
Phillips Petroleum Co.	Phillips, Texas	Catalytic Reforming Unit	16,000 bbls.	$5,395,000	Complete			Procon	Procon
Phillips Petroleum Co.	Phillips, Texas	Dehydration Unit			Complete				
*Phillips Pet.	Sweeny, Texas	Nat. Gas. Liquid Fractionation	30,000 bbls.		Planning	Dec., 1956			
		H. F. Alkylation	2,000 bbls.		Planning	Dec., 1956			
		Gas Cracking Facilities	5,500 bbls.		Planning	Dec., 1956			
*Phillips Petroleum	Andrews, Texas	Nat. Gaso. Plt.			Under Constr.	1956		Phillips	Phillips
*Phillips Petroleum	Crane, Texas	Nat. Gaso. Plt.			Under Constr.	1956		Phillips	Phillips
Phillips Chemical	Sweeney, Texas	Ethylene	329,000 lbs.	$12,357,000	Planning	Dec., 1956			S&W, Badger Div.
Phillips Chemical	Pasadena	Polyethylene	301,000 lbs.	$31,525,000	Planning	Aug., 1956		Phillips	
*Phillips Chem.	Phillips, Texas	Exp. Copolymer Plt.			Under Constr.	Sept., 1956			
Premier Pet. Co	Longview, Tex.	Cat. Poly. Plt.			Under Constr.				
The Pure Oil Co.	Smith Bluffs, Texas	Cat. Reformer	12,000 bbls.		Under Constr.	Spring, 1956	Standard-Ind.	Parsons	Parsons
*The Pure Oil Co.	Smith Bluffs, Tex.	Feed Preparation	20,000 bbls.		Under Constr.	Spring, 1956	Standard, Ind.	Parsons	Parsons
Shell Chemical	Norco, La.	Hydrogen Peroxide Offsite Facl.			Engineering	End, 1955		Braun, Fluor	Braun, Fluor
Shell Oil	Houston	Cat. Reformer	16,000 bbls.		Under Constr.	Early, 1956		Procon	Procon
*Shell Oil Co.	Houston	Cat. Reformer	16,000 bbls.		Under Constr.	Early, 1956			Procon
		Hydrodesulfurization Unit	16,000 bbls.		Under Constr.				Procon
Shell Chemical	Houston	Bisphenol Expan.			Under Constr.	1st Qtr., 1956		Lummus	Lummus
Sinclair Refining	Houston	SO3 Sulfonation		$2,200,000	Under Constr.	Jan., 1956		Badger	Badger
Sinclair Refining	Houston, Texas	Cat. Reformer	24,000 bbls.	$16,500,000	Under Constr.	April, 1956	Sinclair	Kellogg	Kellogg
Standard Oil Co. of Texas	El Paso, Texas	Platformer	4500 bbls.	$2,700,000	Complete		U.O.P.	Bechtel	Bechtel
Southwest Gas	Dubach, La.	Reforming Unit	1,800 bbls.	$750,000	Under Constr.	Nov., 1955			Fish
Southwestern Oil & Refining	Corpus Christi, Texas	Platformer	9,000 bbls.	$2,195,000	Planning	Feb., 1956			Treco
Stanolind Oil & Gas Co.	Ector County, Texas	Gas Comp.		$209,000	ODM Cert.				
Stanolind Oil & Gas	Brownsville, Texas	Recondition & Revamp			Under Constr.	Jan., 1956		Lummus	Lummus
Sunray Mid-Continent	Branch, La.	Cycling & Gaso. Plt.	24 Mmcf	$1,500,000	Under Constr.	Dec., 1955		Tuloma	Tuloma
Sunray Mid-Continent	Chruch Point, La.	Nat. Gaso. Plt.			Under Constr.				
Sunray Mid-Continent	Ingleside, Texas	Nat. Gaso. Plt.	140 Mmcf.	$3,000,000	Under Constr.	Feb., 1956		Dresser	Dresser
Suntide Refining Co.	Corpus Christi, Texas	Aliphatic Naphtha Solvent	5000 bbls.		Planned			U.O.P. Staff	
Texas Butadiene & Chemical Corp.	Houston	Aviation Alkylate, Butylenes & Butadiene		$26,000,000	Planned	Late 1956			Fluor
*Texas Eastman	Longview, Texas	Inc. Oxo Fac.			Planning	1956			
*Texas Gulf Producing	Odessa, Texas	Exp. Gaso. Plt.	†35 Mmcf	$1,250,000	Under Constr.				Fish
Texas Natural Gasoline Corp.	Coke County, Texas	Gathering System & Nat. Gaso. Plt.	70 Mmcf		Completing			Fluor	Fluor
ROCKY MOUNTAIN									
*American Gilsonite	Fruits, Colo.	Gasoline from Gilsonite	7000 bbls.	$10,000,000	Under Constr.	Late 1956			
Atlantic Refining Co.	Lovington, N.M.	Natural Gas	25 Mmcf.		Projected				
Big West Oil	Kevin, Mont.	Cat. Reformer	1,000 bbls.	$500,000	Under Constr.	Oct., 1955	U.O.P.	Procon	Procon
*Carter Oil	Billings, Mont.	Hydroformer	2500 bbls.		Under Constr.	Jan., 1956	Esso R&E	Fluor	Fluor
		Hydrofiner	6000 bbls.		Under Constr.	Jan., 1956	Esso R&E	Fluor	Fluor
*Continental Oil	Billings, Mont.	Ref. Exp.	8500 bbls.	$1,000,000	Under Constr.	Jan., 1956	Union	Staff	Stearns-Rogers
*Continental Oil	Artesia, N. M.	Reformer	1500 bbls.	$500,000	Planning	Early 1956			
Continental Sulphur & Phosphate Corp.	Thermopolis, Wyoming	Sulfur Extraction	50 tons/yr.		Under Constr.		American Sulfur & Refining		Chemico
Cullen Group	Newcastle, Wyo	Gas Plt.		$4,500,000	Planned				
Famarins Oil & Refining Co.	Monument, N. M.	Cat. Reforming Unit	650 bbls.	$375,000	Under Constr.	Nov., 1955	U.O.P.	U.O.P.	Famarins Oil & Refining Co.
*Famarins, O&R	Monument, N. M.	Unifiner	1,000 bbls.	$100,000	Under Constr.	Nov., 1955	UOP	UOP	Staff
First National Petroleum Corp.	Jensen, Utah	Ref. Expan.	To 3,000 bbls.		Planned				
Frontier Refining Co.	Cheyenne, Wyo.	Ref. Expan.	17,500 bbls.	$1,500,000	Under Constr.	Summer, 1955	U.O.P.	U.O.P.	Procon
Pure Oil Co., et al	Adena Field, Colo.	Nat. Gaso. Plt.	20 Mmcf	$3,000,000	Complete				Stearns-Roger
Skelly Oil	Denver	Cat. Reformer			Under Constr.				
*Socony Mobil	Casper, Wyo.	Thermal Crkg.			Engineering	June, 1956		Stearns-Rogers	Stearns-Rogers
Standard-Indiana	Casper, Wyo.	Heavy Oils, Mod. & Expan.			Planning	1957			
The Texas Co	Casper, Wyo.	Cat. Reformer	4,800 bbls.		Engineering	2nd Qtr., 1956	U.O.P.	Fluor, U.O.P.	Fluor
Union Oil Co. (Calif.)	Rifle, Colo.	Shale Oil Pilot Plt.		$5,000,000	Under Constr.			Stearns-Rogers	
U. S. Steel Corp	Geneva, Utah	Anhydrous Ammonia	200 tons	$20,000,000	Planned	1956		Blaw-Knox	Blaw-Knox
Western States Refg.	Salt Lake City	Cat. Reformer	1,000 bbls.	$300,000					
WEST COAST									
Brea Chemicals, Inc.	Brea, Calif.	Nitric Acid & Ammonium Nitrate Plt.	150 tons	$3,000,000	Under Constr.	Sept., 1955		C & I	C & I, Macco
California Stray Chemical	Richmond, Calif.	Fertilizer Plt.		$3,000,000	Planning	Mid-1956			
Calstate Refg. Co.	Signal Hill, Calif.	Hyperformer Unit	1,100 bbls.	$300,000	Complete		Union Oil		Calstate
Caminol	Hanford, Calif.	Petroleum Refining Fac.		$1,600,000	ODM Approved				
Carbide & Carbon Chemicals Company	Torrance, Calif.	Polyethylene Plt.	60 million lbs./yr.	$36,000,000	Under Constr.	End, 1955			
Columbia River Chemicals	Pasco, Wash.	Anhydrous Ammonia	100 tons	$12,000,000	Under Constr.	Late 1955		Fluor	Fluor
		Urea	110 tons						
		Ammonium Sulfate	140 tons						

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Consolidated Mining & Smelting	Portland, Ore.	Urea Plt.	100 tons	.....	Planning	.....	.....	.....	.....
		Ammonia Plt.	200 tons	.....	Planning	.....	.....	.....	.....
*Dow Chemical	Torrance, Calif.	Exp. Styrene Plt.	.....	.....	.....	Dec., 1955	.....	.....	.....
Du Pont	Antioch, Calif.	Fluorinated Hydrocarbons. Tetrethyl Lead	.....	.....	.....	4th Qtr., 1956	.....	.....	.....
*Dupont	Antioch, Calif.	Sodium, Ethyl Chloride, Trichlorethyene, Perchorethylene	.....	.....	Planning	1st Qtr., 1957	.....	.....	.....
Fletcher Oil Co.	Wilmington, Calif.	Topping Unit	10,000 bbls.	$976,000	ODM Cert.	.....	.....	.....	.....
General Petroleum	Ferndale, Wash.	Refinery Expan. Pretreaters, Boilers, Soverformer	.....	$5,600,000	Under Constr.	1956	.....	E & A	E & A
*Golden Bear Oil	Bakersfield, Cal.	Vacuum Unit	3500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Hancock Oil Co.	Signal Hill Calif.	Fluid Coking Unit	6,000 bbls.	$1,814,800	ODM Certified	.....	.....	.....	.....
Hancock Oil Co.	Long Beach	Cat. Reformer	2,500 bbls.	$550,000	ODM Certified	.....	.....	.....	.....
Pacific Oil & Refining Co.	Tacoma, Wash.	Refinery	10,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
*Phillips Pacific	Washington	Ammonia Plt.	200 tons	.....	Planning	Late 1956	.....	Phillips Chem.	Fish
Richfield Oil	Watson, Calif.	Cat. Reformer	17,000 bbls.	.....	Under Constr.	Mid-1956	Sinclair-Bakers	Parsons-Staff	Parsons
Rothschild Oil	Santa Fe Springs, Calif.	Cat. Crker.	6,000 bbls.	$2,000,000	.....	.....	.....	.....	Braun
*Shell Chemical	Ventura, Calif.	Urea Plt.	.....	.....	Engineering	Sept., 1956	Montecatini	Kellogg	Kellogg
Shell Chem. Corp.	Martinez, Calif.	Ionol Plt. Exp.	.....	.....	Complete	.....	.....	Staff	Staff
Shell Oil	Anacortes, Wash.	Refinery	50,000 bbls.	$75,000,000	Completing	Nov., 1956	.....	Bechtel	Bechtel
Standard (Calif.)	Richmond, Calif.	Ammonia Plt.	300 tons	$12,800,000	Engineering	Mid-1956	.....	Kellogg	Kellogg
Standard (Calif.)	Richmond, Calif.	Nitric Acid Plt.	225 tons	.....	Planning	Mid-1956	.....	C. & I.	.....
Standard (Calif.)	Richmond, Calif.	Isophthalic Plt.	50 mln. lbs./yr.	$10,900,000	Engineering	Nov., 1955	.....	Staff	Ferguson
Standard Oil (Calif.)	Honolulu	Refinery	20-30,000 bbls.	$25-30,000,000	Planned	Late 1957	.....	.....	.....
Stauffer Chemical	Compton, Calif.	Sulfuric Acid	.....	$57,070	Engineering	.....	.....	.....	.....
Stauffer Chemical	Richmond, Calif.	Sulfuric Acid	.....	$283,500	.....	.....	.....	.....	.....
Sunset Oil Co.	Portland, Ore.	Refinery	20,000 bbls.	.....	Considering	.....	.....	.....	.....
*The Texas Co.	Pacific NW.	Refinery	.....	.....	Planning	.....	.....	.....	.....
*The Texas Co.	Wilmington, Cal.	Desasphalter	13,000 bbls.	.....	Under Constr.	2nd Qtr., 1956	.....	Texaco	Texaco
The Texas Co.	Wilmington, Calif.	Furfural Unit	25,000 bbls.	.....	Under Constr.	1st Qtr., 1956	.....	Staff	Staff
Tide Water	Avon, Calif.	Fluid Coker	42,000 bbls.	.....	Under Constr.	May, 1956	.....	Bechtel	Bechtel
		Hydrodesulfurizer	24,000 bbls.	.....	Planning	Spring, 1956	.....	.....	.....
		Gas Plt.	.....	.....	Planning	Spring, 1956	.....	.....	.....
		Exp. Fluid Cat. Cracking	.....	.....	Planning	Spring, 1956	.....	.....	.....
Union Oil (Calif.)	Los Angeles	Fac. for Handling Enriched Crude	.....	$1,650,000	Completing	Oct., 1955	.....	Fluor	Fluor
Union Oil Co. (Calif.)	Los Angeles	Gas, Oil & Heavy Side Cut Strippers	.....	$250,000	Completing	Oct., 1955	.....	Fluor	Fluor
Union Oil (Calif.)	Los Angeles	Terminal; Lube Oil Blending	.....	$3,000,000	Under Constr.	Jan., 1956	.....	Bechtel	Bechte
*Union Oil (Calif.)	Edmonds, Wash.	Two Asph. Stills	100 tons	$400,000	Under Constr.	Early 1956	.....	E&A	.....
*Union Oil (Calif.)	Oceano, Calif.	Sulphur Recov.	42 tons	.....	Engineering	Early 1956	.....	Girdler	Bechtel
OUTSIDE U.S.A.									
Canada									
*Anglo American Explorations	Hartell, Alta.	Cat. Reformer	1000 bbls.	$300,000	Under Constr.	Dec., 1955	Atlantic	Grebe-Doremus	Grebe-Doremus
*Anglo-Canadian	Sarnia, Ont.	Ref. Exp	25,000 bbls	.....	Under Constr	1956	.....	.....	.....
			30,000 bbls.	.....	Under Constr.	1957	.....	.....	.....
British American Oil	Clarkson, Ont.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
British American Oil	Moose Jaw, Sask.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
British American Oil	Edmonton, Alta.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
British-American Oil Co.	Calgary	Cat. Reformer	2,000 bbls.	.....	Complete	.....	Atlantic	Fluor	Fluor
British-American Oil Co.	Montreal	Cat. Reformer	13,000 bbls.	$3,000,000	Under Constr.	Late, 1955	Atlantic	Lummus	Lummus
British Dominion Oil Co.	Southern Alberta, Canada	Ammonium Nitrate	.....	$1,800,000	Planning (Unconfirmed)	.....	.....	.....	.....
Can-Amera Oil-Sands Development, Ltd.	Edmonton, Alta.	Processing Plt.	.....	.....	Unconfirmed	.....	.....	.....	.....
Can-Amera Oil Sands	Bitumount, Alba.	Oil-Sands Separat on Plt.	500 bbls.	$300,000	Under Constr.	Sept., 1955	.....	.....	.....
Canadian Gulf Oil	Stettler, Atba.	Nat. Gaso. Plt.	12 Mmcf	$2,000,000	Under Constr.	March, 1956	.....	Mannix Gill	Mannix Gill
Canadian Hydrocarbons, Ltd.	Winnipeg, Manitoba	Ammonia Plt.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Canadian Industries (1954)	Millhaven, Ont.	Anhydrous Ammonia Plt.	200 ton	$9,000,000	Under Constr.	Mid, 1956	.....	Girdler (Canada)	Girdler (Canada
Canadian Industries, (1954) Ltd.	Milhaven, Ont.	"Terylene" Plt.	11,000,000 lbs./yr.	$20,000,000	Complete	.....	.....	Ferguson	Ferguson
Canadian Oil Companies, Ltd.	Sarnia, Ontario	Carbon Monoxide Steam Generator	.....	$400,000	Completing	Oct., 1955	.....	.....	Combustion Engineering
*Canadian Oil Refineries, Ltd.	Sarnia, Ont.	Exp. Crude Unit, Cat Cracker, Platformer	10,000 bbls.	$2,200,000	Under Constr.	Oct., 1956	.....	Staff	.....
Canadian Petrofina, Ltd.	Montreal, Quebec, Canada	Refinery	20,000 bbls.	$20,000,000	Complete	.....	Houdry, Standard of Ind., Kellogg, Standard of N.J.	.....	Canadian Kellogg & Lummus
Canada Southern Oils	Saskatchewan	Refinery	10-20,000 bbls.	$7,000,000-$10,000,000	.....	.....	.....	.....	.....
Ethyl Corporation of Canada, Ltd.	Sarnia, Ont.	Anti-Knock Compound Plt.	.....	$14,000,000	Planning	Early, 1956	.....	.....	.....
Excelsior Refineries, Ltd.	Dawson Creek, B.C.	Refinery	2,000 bbls.	$1,500,000	Under Constr.	End, 1955	.....	.....	.....
Hooker Chemicals, Ltd.	N. Vancouver, B. C.	Chemicals	.....	.....	Projected	.....	.....	.....	.....
Husky Oil & Refining, Ltd.	Moose Jaw, Sask.	Catformer, Desulfurization Unit, Vacuum Dist., Vis-Breaker, Crude Furnace	15,000 bbls.	.....	Complete	.....	Atlantic, Husky	Fluor	Fluor

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Husky Oil & Refining, Ltd.	Port William, Ont.	Expansion Catformer, Desulfurization Unit Asphalt Plt.	†5,000 bbls.	$1,000,000	Complete		Atlantic	Fluor	Fluor
Husky Oil & Refining, Ltd.	Lloydminster, Alba.	Refinery Expan.	†8,500 bbls.	$1,000,000	Complete				
Imperial Oil	Sarnia	Expan. of Wax Facl.		$4,500,000		Late, 1956			
*Imperial Oil	Sarnia, Ont.	Cat. Reformer	13,500 bbls.	$7,200,000	Under Constr.	Oct., 1956		Fluor; Imperial	Fluor
Imperial Oil, Ltd.	Edmonton, Alberta	Lube Oil Plt.	2,000 bbls.	$13,000,000	Complete			Staff & Can. Kellogg	Can. Kellogg
Imperial Oil, Ltd	Imperoyal, Canada (near Halifax)	Rebuild Existing Plt. including Fluid Cat. Cracker	41,625 bbls.	$22,300,000	Under Constr.	April, 1956		Foster Wheeler, Ltd.	Foster Wheeler Ltd.
Imperial Oil, Ltd	Ioco, B.C.	Naphtha Fractionator & Cat. Poly. Plt.	2,400 bbls.	$2,400,000	Completing			Staff & Can. Bechtel	Can. Bechte
Inland Chemicals Canada, Ltd.	Fort Saskatchewan, Alta.	Sulfuric Acid Plt.	100 tons	$1,000,000					Lummus of Canada
International Waxes, Ltd.	Toronto	Wax Percolation	†140,000 lb.	$350,000	Complete				
Kendall Refg. of Canada	Toronto, Canada	Cracker	27,000 bbls.			Summer, 1956			
		Lub. Oil Compounding, packaging & Distrib Plt.			Considering	Indefinite			
Midland Pet. & Pacific Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.	$2,000,000	Under Constr.				
*North Star Oil	Grand Prairie, Alta.	Re-Locate Refinery	2500 bbls.	$3,000,000	Engineering	June, 1956	Kellogg	Kellogg	Kellogg
North Star Oil, Ltd.	St. Boniface	Refinery	12,000 bbls.	$10,000,000	Complete		U.O.P.	Can. Kellogg	Can. Kellogg
*Northwest-Nitro Chemical	Medicine Hat, Alta.	Phosphoric-Acid Plt.							Fluor
Northwest Nitro-Chemicals, Ltd.	Medicine Hat, Alberta	Nitrogen Plt.		$23,000,000	Under Constr.	End, 1956		Commercial Solvents	Ford, Bacon & Davis, Kellogg
Polymer Corp., Ltd.	Sarnia, Ont.	Ethylene Plt. Expan.		$2,000,000	Under Constr.	1956		Staff	Staff
Polymer Corp., Ltd.	Sarnia, Ont.	Additional Turbo-generator—Steam and Power Plt.		$500,000	Equipment	1956			Canadian General Electric
*Quebec Ammonia	Varennes, near Montreal	Synthetic Ammonia	120 tons		Planning				
		Refinery: Crude Unit, Thermal Cracker	2,000 bbls.	$2,000,000	Under Constr.	Nov., 1955		Koch	Bohna-Lane
*Royalite Oil Co.	Coleville, Sask.	Vacuum Unit	3,800 bbls.	$170,000	Complete			Caribou Eng. Co., Ltd.	Company Construct.
*Shell Oil (Canada)	Montreal, East	Topping Expan.	11,000 bbls.		Planned	Mid. 1956			
		Platformer	6,000 bbls.		Planned	Mid, 1956			
		Hydrodesulfurizer	7,500 bbls.		Planned	Mid, 1956			
		Increase Cat. Cracking	3,000 bbls.		Under Constr.	End, 1955		Shell	Shell
		Vacuum Flashing	12,700 bbls.		Under Constr.	End, 1955		McKee	McKee
		Offsite Facl.			Planned	Mid, 1956		Fluor	Fluor
		Platformer	2,750 bbls.		Under Constr.		U.O.P.		Procon
Shell Oil (Canada)	Shellburn B.C.	Platformer	3,300 bbls.	$1,500,000	Planning	Late, 1955			
Sherritt-Gordon Mines, Ltd.	Fort Saskatchewan, Alta.	Anhydrous Ammonia	75 tons	$24,000,000	Planned				
Standard Oil (B.C.)	Stanovan, B.C.	Platformer	2,750 bbls.	$2,500,000	Under Constr.	Late, 1955	Standard (B.C.)	Procon Can.	Procon, Can.
Texaco Oil Co.	Edmonton, Canada	Gas Absorp. Plts.		$6,000,000	Under Constr.				
Wainwright Producers & Refiners	Edmonton,	Cap. Inc.	†2,300 bbls.		Under Constr.			Treco	Treco
*X-L Refineries	Dawson Creek, B.C.	Refinery	2000 bbls.	$2,000,000	Under Constr.	Nov., 1955	Koch, Houdry	Koch	Bohna; Lane
LATIN AMERICA									
Argentina									
Esso Refinadora Petroleo, S.A.	Argentina	Lubricating Oil Plt.	375,000 bbls. a year		Planning				
*Fabrica Argentina	San Nicholae	Phenol Plt.		$375,000	Planning	Fall, 1956			
Yacimentos Petroliferos Fiscales (ENDE)	Cerro Bandera P. Huincul Neuquen	Dehydration Plt.	10,400 bbls.		Under Constr.	1955		Y.P.F.	Y.P.F
Brasil									
Cia de Petroleo de Amazonia	Manaus	Refinery; Cat. Crker. & Aux. Units	5,000 bbls.	$4,500,000	Engineering	Late 1955	U.O.P.	Sweco	Sweco
Cia Brasiliera de Estireno	Cubatao	Styrene Monomer Plt.			Engineering		Koppers, Firestone	Koppers	Koppers
		Asphalt Plt.	3,500 bbls.	$1,300,000	Under Constr.	Nov., 1955		SWECO	SWECO
		Anhydrous Ammonia	100 tons	$8,000,000	Under Constr.	Early, 1956	Texaco Dev., Ammonia Casale	Foster Wheeler	Foster Wheeler Staff
		Nitric Acid	345 tons						
		Ammonian Nitrate Fertilizer	35 tons 340 tons	$11,000,000	Under Constr.	Early, 1956		Friedrich Uhde Uhde	Uhde, Staff
*Petrobras	North Brazil	Refinery	25,000 bbls.		Studying				
*Petrobras	South Brazil	Refinery	70,000 bbls.		Studying				
Chile									
*The Texas Co.	Santiago	Refinery	20,000 bbls.		Planning				
Colombia									
Colombian Petro-Company	Barco Concession	Gas Treating Plt.	2,000 bbls.	$5,000,000	Under Constr.				
International Petroleum (Columbia), Ltd.	Cartagena	Refinery	25,000 bbls.	$35,000,000	Planned	Late 1957			
Cuba									
*Esso Standard	Havana	Ref. Exp.	†30,000 bbls.	$3,000,000	Planning				
*Refinadora Cabaiguan	Cabaigun, Cuba	Ref. Expan.			Planning				
Shell de Cuba	Havana	Refinery	25,000 to 30,000 bbls.	$19,000,000	Planning	Nov., 1956			Bechtel

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Mexico									
Cia Commercial Vacuum	Mexico, D.F.	Lube Oil Blending, Compounding	570 bbls.	$700,000	Planning	2nd Qtr., 1956	.....	.....	.....
Petroleos Mexicanos..	Arbol Grande Tamaulipas	Improvements	.....	.....	Engineering	1955	.....	Staff	Staff
Petroleos Mexicanos.	Ciudad Madero Tamaulipas	Enlarge,Modern-Feed prep. Cat. Crker. Fluid-coker, Offsite	100,000 bbls.	$30,000,000	Planned	Early 1957	.....	.....	.....
Petroleos Mexicanos..	Reynosa	Enlarge Topping Unit Thermal Cracking	5,000 bbls 2,000 bbls.	.....	Engineering	Late 1955	U.O.P.	Staff	Staff
Petroleos Mexicanos..	Mata Redonda	Refinery Expan.	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos.	Minatitlan	Topping, Feed Prep., TCC Cat. Crker., Poly. Offsite	25,000 bbls.	$12,000,000	Complete	.....	Socony, U.O.P.	Fluor	Staff
Petroleos Mexicanos..	Mexico, D. F.	Cap. Increase	50,000 bbls.	$12,000,000	Complete	.....	.....	McKee	Staff
Petroleos Mexicanos..	Pacific Coast	Refinery	30,000 bbls.	.....	Planned	.....	.....	.....	.....
Petroleos Mexicanos..	Tampico	Refinery Expan.	.....	.....	Planning	.....	.....	.....	.....
Netherlands Antilles									
N. V. Curacaosche Petro. Ind. Mij.	Curacao	Vacuum Still	20,000 bbls.	Part of $56,000,000 Project	.....	1956	.....	S & W. Badger Div.	.....
		Cat. Crker.	35,000 bbls.	.....	Planned	End, 1957	.....	.....	.....
		Catalytic Oil Gasification	.....	.....	Planning	.....	.....	H.W.P.	.....
Peru									
Fertiza Limitada.....	Peru	Fertilizer Plt.	.....	.....	Planning	1956	.....	Montecatini	.....
Helios, S.A..	San Andres	Fertilizer Plt.	130,000 tons	.....	Planning	.....	.....	.....	.....
Helios, S.A.	San Andres	Lube Oil; Asphalt Refinery	60,000 tons lube oil; 10,000 tons Asphalt/yr.	$8,000,000	Projected	Early 1956	.....	Hydrocarbon	.....
Puerto Rico									
Americo Rodriques	San Juan	LPG Plt.	12,000 bbls.	.....	Under Constr.	.....	.....	Fluor	Fluor
Caribbean Refining	San Juan	Refinery	10,000 bbls.	$11,000,000	Complete	.....	U.O.P.	Fluor	Fluor
Commonwealth Oil Refining Co.	Guayanilla Bay	Refinery:	25,000 bbls.	$25,000,000	Under Constr.	.....	.....	Lummus	Lummus
		Houdriflow Cat. Crker.	26,800 bbls.	.....	.....	.....	.....	.....	.....
		Houdriformer	3,730 bbls.	.....	.....	.....	.....	.....	.....
Gonzales Chemical....	Guanica,	Ammonia	115 ton	$12,250,000	Planning	.....	.....	Lummus	Lummus
Venezuela									
Cia Shell de Venesuela	Cardon	Cat. Crker.	35,000 bbls.	Part of $56,000,000 Project	Planned	End, 1957	.....	.....	.....
Cia Shell de Venesuela	Cardon	Catalytic Oil Gasification; Polymerisation; Treater, Feed Preparation	.....	.....	Planning	.....	.....	H.W.P.	.....
Creole Pet. Corp.....	Amuay Bay	Pipe Still	100,000 bbls.	$10,800,000	Engineering	August 1956	.....	Foster Wheeler	Foster Wheeler
N.V. Bataafsche Petroleum Maatschappij	Cardon	Vacuum Still	66,000 bbls.	.....	.....	1956	.....	S & H Badger Div.	.....
*RichmondExploration	Haracaibo	Asphalt Plt.	10,000 bbls.	.....	Planning	.....	.....	.....	.....
Venesuelan Government	Puerto La Cruz	Petrochemical Plt.	.....	.....	Planning (Unconfirmed)	1956	.....	Montecarini	.....
*Venezuela Gulf.....	Puerto La Cruz	Visbreaker	14,000 bbls.	.....	Under Constr.	2nd Qtr., 1956	.....	Gulf	Gulf
EUROPE AND AFRICA									
Belgium									
*Esso.....	Antwerp	Exp. Ref.	.....	.....	Planning	.....	.....	.....	.....
Petrochim.....	Antwerp	Ethylene Oxide, Ethylene Glycol	.....	$8,000,000	Engineering	.....	SD	SD	.....
Denmark									
A. P. Moeller.....	Copenhagen	Refinery	.....	$11,500,000	Planning	.....	.....	.....	.....
Egypt									
*Anglo-Egyptian.....	Suez	Ref. Expan. & Mod.	.....	.....	Planning	.....	.....	.....	.....
Egyptian Government	Cairo	Refinery	43,000 bbls.	.....	Under Constr.	.....	.....	Lummus	Lummus
England									
Berry Wiggins & Co., Ltd.	Wenste Ref., Manchester.	Extension to Refinery	500 bbls.	.....	Under Constr.	.....	.....	H.W.P.	H.W.P.
British Petroleum....	Kent	Oil Gasification	15 Mmcf	.....	Planning	.....	.....	.....	.....
*British Petroleum...	Kent	Hydrofiner	8000 bbls.	.....	Planning	1956	.....	.....	.....
Esso Petroleum Co...	Fawley	Refinery Expan. Including Hydroforming Unit	†35,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
Hedon Chemicals	Hedon, Yorks.	Vinyl Acetate	.....	.....	Under Constr.	.....	.....	.....	.....
Imperial Chemical Industries	Billingham,	Alcohols	†40,000 tons/yr.	.....	Engineering	End, 1956	.....	Staff	.....
Imperial Chemical Industries	Wilton	Chemical Plt.	30 tons	.....	.....	1956	.....	S & W Badger Div.	E. B. Badger & Sons, Ltd.
Imperial Chemical Industries	Wilton	Terylene Plt.	22 mln. lbs./yr.	$50,000,000	Nearing Completion	1955/1956	.....	.....	.....
Imperial Chemical Industries	Wilton	Butadiene Separation Plt.	6/7000 ton/yr.	.....	Design	.....	.....	H.W.P.	.....
Imperial Chemical Industries	Wilton	Extension of Cracker	†250,000 tons/yr.	.....	Under Constr.	3rd Qtr., 1956	.....	Staff and Kellogg	KIC
Monsanto Chemicals	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
Monsanto Chemicals	Britain	Styrene-Butadienne Copolymer Plt.	4,000 tons/yr.	$14,000,000	Planned	.....	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Hydrodesulfurization	5,200 bbls.	.....	Under Constr.	Early 1955	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Isopentane Plt.	.....	$1,400,000	Under Constr.	Early, 1955	.....	H.W.P.	.....
Shell Refining & Marketing Co.	Shell Haven	Cat. Reformer	6,700 bbls.	.....	Under Constr.	End, 1955	.....	.....	.....
*Vacuum Oil.....	Coryton	Sovaformer	.....	.....	Engineering	July, 1956	.....	Bechtel	Bechtel
Finland									
Neste Oy Corp.....	Turku, Finland	Refinery	14,000 bbls.	$17,500,000	Planning	.....	.....	.....	.....
France									
*Antar Petroles de l'Atlantic	Dinges	Cat. Reformer	10,800 bbls.	.....	Planning	.....	Houdry	Hydrocarbon	Hydrocarbon
Comp. de Raffinage	Petit Couronne	Cat. Crker.	8,000 bbls.	.....	Under Constr.	Mid 1956	.....	.....	.....
Shell Berre		Vacuum Still	33,000 bbls.	.....	.....	1955-56	.....	S & W Badger	.....
Comp. Francaise de Raffinage	Gonfreville	Refinery Expan.	.....	.....	Under Constr.	Mid, 1956	.....	Kellogg	KIC

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Houilleres du Bassin du Nord et du Pas-de-Calais	Bully-Les-Mines	Ethane Cracking Plt.	20 tons	.....	.....	1955	.....	S & W Badger Div.	.....
*Pechiney	St. Auban	Perchlorethylene Plt.	.....	.....	Planning	.....	SDC	SDC	.....
Societe du Caoutchouc Butyl	Le Havre	Synthetic Rubber Plt.	20,000 tons/yr.	.....	Planning	.....	.....	.....	.....
Societe des Raffineries de Petrole de la Gironde	Ambes	Cat. Crker.	4,600 bbls.	.....	Engineering	1957	U.O.P.	U.O.P.	Lummus
		Vacuum Unit	6,300 bbls.	.....	Engineering	1956	.....	Lummus	Lummus
	Ambes	Poly Plt.	540 bbls. (Product)	.....	Engineering	1956	C.R.C.	Foster Wheeler	Lummus
West Germany									
*British Petroleum	Hamburg	Hydrofiner	5250 bbls.	.....	Planning	1956	.....	.....	.....
		Increase LPG Plt.	†50,000 t/y	.....	Complete	.....	.....	.....	.....
Chemische Werke Huels, A.G.	West Germany	Synthetic Rubber Plt.	30,000 t/y	$24,000,000	Considering	Esso R&E; Houdry	Cat. Constr.	.....	.....
*Deutsche Shell	Hamburg	Exp. Ref.	†52,000 bbls.	.....	Planning	.....	.....	.....	.....
*Esso	Cologne	Refinery	.....	.....	Planning	.....	.....	.....	.....
Gewerkschaft Erdoel Raffinerien Emsland	Lingen	Houdriformer	3,500 bbls.	.....	Under Constr.	End, 1955	Houdry	Lummus	Lummus
Kali Chemie Co.	Neinberg	Bead Catalyst Plt.	.....	.....	Licensed	.....	Soc.-Vac.	.....	.....
*Kohle-Oil Chemie	Gelsenkirchen	Polyethylene	24,000 ton/yr.	.....	Planning	.....	.....	.....	.....
Greece									
Greek Government	Piraeus	Refinery	30,000 bbls.	$15,000,000	Under Constr.	Jan., 1957	Atlantic	Hydrocarbon	Hydro. M, Krupp, Stahlunion, Stahlbau
Ireland									
Erie Government Esso Petr. (Ireland) Caltex (Ireland) Irish Shell	Ireland	Refinery	.....	.....	Planning	.....	.....	.....	.....
Italy									
Ente Nazionale Idrocarburi	Ravenna	Butadiene Plt.	30,000 tons a yr. Rubber	75,000,000	Planning	.....	.....	Union Carbide Carbon;	.....
		Copolymer Plt.	350,000 tons a year, Nitrogen Fertilizers		Planning	.....	.....	Phillips Petroleum	.....
Azienda Generale Italiana Petroli	Venice	Platformer	1,750 bbls.	.....	Under Constr.	.....	.....	.....	.....
Azienda Generale Italiana Petroli	Cagliari	Refinery	500,000 tons	.....	Planning	.....	.....	.....	.....
Golfo Industria Petrolifera S.P.A.	Gaeta, Italy	New Refinery	15,000 bbls.	.....	.....	.....	.....	Tecnider	.....
Industria Raffinazione Olii Minerali	Venice	Platformer	2,000 bbls.	.....	Under Constr.	1st. Qtr., 1956	U.O.P.	Procon	C.T.I.P.
Montecatini	Barranca Bermeja	Anhydrous Ammonia Plt.	50 tons	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Purfina Italiana,	Genoa	Platformer	1,000 bbls.	$550,000	Designing	Spring, 1956	U.O.P.	Staff	Staff
Purifina Italiana	Milan	Distillation Unit	†5,000 bbls.	.....	Planning	.....	.....	.....	.....
*Shell Italiana	Palermo	Refinery	20,000 bbls.	.....	Planning	.....	.....	.....	.....
Societa Per Azioni Raffineria Olii Minerali (SAROM)	San Martino di Trecate (Novara)	Cat. Crker.	2,880 bbls.	.....	Nearing Completion	.....	U.O.P.	U.O.P., E. B. Badger, Ltd.	S&W Badger Div.
		Vacuum Unit	5,150 bbls.	.....	Under Constr.	.....	.....	S&W Badger	S&W Badger Div.
		Poly. Plt.	315 bbls.	.....	Under Constr.	.....	C.R.C.	Foster Wheeler	S&W Badger Div.
*SAROM	Ravenna	Iso-Plus Houdriformer	4000 bbls.	.....	Planning	July, 1955	Houdry	Houdry; Lummus	Breda
Netherlands									
Caltex Petroleum	Pernis	Platformer	7,000 bbls.	.....	Engineering	1957	U.O.P.	Lummus, Ltd.	Lummus-Werkspoor
		Desulfurization	4,000 bbls.	.....	Engineering	1957	U.O.P., Union	Lummus, Ltd.	Lummus-Werkspoor
Mekog	Velsen-Ymuiden	Nitrigen Fertilizer	.....	$9,000,000	Planning	.....	.....	.....	.....
Nederlandsche Dow Maatschappij N.V.	Rotterdam	Petrochemical Plt.	.....	.....	Planned	.....	.....	.....	.....
N. V. de Bataafsche Petroleum Maatschappij	Pernis	Catalytic Oil Gasification	.....	.....	Planning	.....	.....	H.W.P.	.....
N. V. de Bataafsche Pet. Maatschappij	Pernis	Vacuum Still	66,000 bbls.	.....	Under Constr.	1955-56	.....	S&W Badger Div., E. B. Badger, Ltd.	.....
		Luboil Ref. Exp.	1,750 bbls.	.....	Complete	.....	.....	.....	.....
		Cat. Crker.	33,000 bbls.	.....	Under Constr.	Mid 1956	.....	.....	.....
Morocco									
Societe Cherifienne des Petroles	Petitjean	Thermofor Cat. Crack.	160,000 tons/yr.	.....	Planning	.....	.....	.....	.....
Portugal									
*Petrofina	Luanda	Refinery	30,000 bbls.	.....	Planning	.....	.....	.....	.....
Scotland									
*British Pet. Chemical	Grangemouth	Additional Cracking	.....	.....	Planning	.....	.....	S&W Badger Div.	E. B. Badger, Ltd.
		Gas-Separating	.....	.....	Planning	.....	.....	S&W Badger Div.	E. B. Badger, Ltd.
		Ethanol, Ethylene, Tetrapropylene	.....	$13,000,000	Planning	1956	Shell Chem. UOP	S&W Badger Div.	E. B. Badger, Ltd.
		Butadiene	.....	.....	Planning	.....	.....	KIC	KIC
Grange Chemicals	Grangemouth	Dodecybenzene Plt.	35 tons	.....	Under Constr.	4th Qtr. 1955	.....	S. W. Badger Div.; E. B. Badger & Sons	Costain-John Brown
Spain									
Instituto Nacional de Industria	Cartagena	Refinery Expan.	†70,000 bbls.	.....	Planning	.....	.....	.....	.....
Rafineria de Petroleos de Escombreras S.A.		Crude Unit	23,000 bbls.	.....	Engineering	1956	.....	Foter Wheeler	.....
		Platformer	8,000 bbls.	.....	Engineering	1956	.....	U.O.P., Foster Wheeler	.....
Sweden									
Johnson Line	Gothenburg	Refinery	2,500 bbls.	.....	Planned	.....	.....	Staff	Staff
Trieste									
S.P.A. Tecnico Industriale Aquila	Trieste	Cat. Cracking	3,300 bbls.	.....	Under Constr.	.....	Soc.-Vac.	Staff	Staff
		Cat. Poly.	1,400 bbls.	.....	Under Constr.	.....	U.O.P.	Staff	Staff
Turkey									
Turkish Government	Istanbul	Nat. Gaso. Plt.	.....	.....	Planning	.....	.....	.....	.....
Turkish Government	Kutahya	Nitrogen Plt.	.....	.....	Projected	.....	.....	.....	.....
Turkiye Petrolleri A.O.	Batman	Refinery	6,950 bbls.	$10,000,000	Under Constr.	Late, 1955	.....	Parsons	Parsons
Union of South Africa									
Caltex (Africa)	Durban	Blending Lube Plt.	.....	$600,000	Under Constr.	1st Half 1956	.....	.....	.....

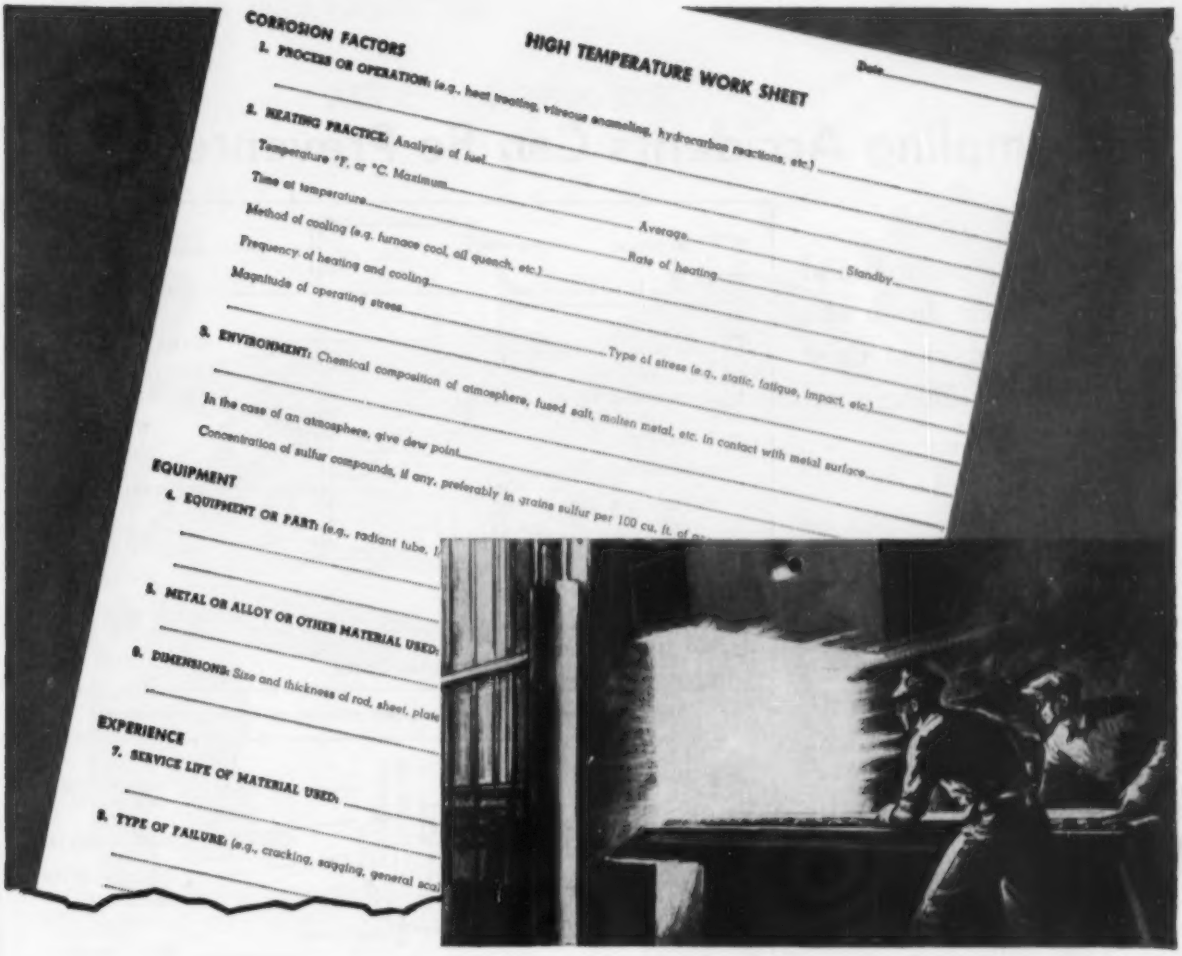
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Union Petrol Refinery, Ltd.	Johannesburg	Refinery	.....	$20,000,000	Projected	.....	.....	.....	.....
Yugoslavia									
Yugoslavia Government	Makarska	Refinery	.....	.....	Planning	.....	.....	.....	.....
NEAR EAST									
Bahrain									
Bahrain Petroleum	Bahrain	Vacuum Still	23,000 bbls.	.....	Under Constr.	1955	.....	Lummus	Foster Wheeler
		Cat. Crker.	18,000 bbls.	.....	Engineering	1957	.....	Foster Wheeler	Foster Wheeler
		Poly Plt.	1,500 bbls.	.....	Engineering	1956	.....	Foster Wheeler	Foster Wheeler
		Vacuum Still	23,000 bbls.	.....	Under Constr.	1956	.....	Lummus	Foster Wheeler
Iraq									
*Iraq Government	Iraq	Lube Oil Plt.	25,000 ton/yr.	.....	Planning	.....	.....	Foster-Wheeler	Foster-Wheeler
Jordan									
Jordanian Reconstruction Council	Mafrak	Refinery	.....	$7,500,000	Planned	.....	.....	.....	.....
Lebanon									
Mediterranean Refinery	Sidon	Refinery Expan. (Increase Crude Unit; Second Platformer)	10,000 bbls.	.....	Under Constr.	End, 1955	U.O.P.	Bechtel Asso., Procon	Bechtel Asso
Saudi Arabia									
Arabian American	Ras Tanura	Asphalt Plt.	1,250 bbls.	.....	Planning	1956	.....	.....	.....
*Arabian American Oil Co.	Ras Tanura	Fluid Cat. Hydroformer	12,500 bbls.	$9,925,000	Under Constr.	Jan., 1956	S.O.D.	Lummus	Lummus
Saudi Arabian Government	Saudi Arabia	Ammonium Sulfate Plt.	400,000 Metric tons/yr. Plus 500 Tons Dry Ice	.....	Proposed	.....	.....	.....	.....
Syria									
Syrian Government	Homs	Refinery	12,000 bbls.	$3,000,000	Considering	.....	.....	.....	.....
FAR EAST									
Burma									
Burma Oil Co.	Chauk	Distil. Unit	2,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Ceylon									
Ceylon Government & Shell of Ceylon	Hendala	Refinery	.....	$40,000,000	Negotiating	.....	.....	.....	.....
India									
Caltex Oil Refining (India) Ltd.	Visakhapatnam	Refinery	13,500 bbls.	.....	Under Constr.	1957	.....	Lummus Foster Wheeler Ewbank & Tardreas	Lummus
*Indian Gov't	Bhavnagar	Refinery	30,000 bbls.	$42,000,000	Considering	.....	.....	.....	.....
Indian Government	India	Synthetic Petroleum Plt.	6,000 bbls.	.....	Planning	.....	.....	.....	.....
Japan									
Idemitsu Kosan Co.	Tokuyama	Refinery	18,000 bbls.	$16,000,000	Planning	.....	.....	.....	.....
Mitsubishi Oil Co., Ltd.	Tokyo	Vac. Distl. Unit	2,000 bbls.	.....	.....	.....	.....	.....	.....
Showa Oil Company	Tokuyama	Refining Fac.	30,000 bbls.	$39,000,000	Planning	June, 1957	.....	.....	.....
Showa Oil Company	Tokuyama	Petrochemicals	.....	.....	Planning	.....	.....	.....	.....
Korea									
Korean Government	Chung-du	Ammonia Plt.	185 tons	$25,000,000	Planning	Mid-1957	.....	.....	.....
Sumatra									
*Standard-Vacuum	Palembang	Cat. Cracker	10,000 bbls.	.....	.....	.....	.....	Foster-Wheeler	Foster-Wheeler
		Polymerization	1100 bbls.	$20,000,000	Planning	.....	.....	Foster-Wheeler	Foster-Wheeler
		Revamp Existing Plt.	.....	.....	.....	.....	.....	Foster-Wheeler	Foster-Wheeler
Formosa									
Chinese Petroleum Corp.	Kaohsiung	Thermofor Cat. Crker.	10,000 bbls.	.....	Under Constr.	1956	Soc.-Vac.	Fluor	Fluor
		Cat. Reformer	3,100 bbls.	.....	Under Constr.	.....	Atlantic	Blaw-Knox	Blaw-Knox
Taiwan Fertiliser, Ltd.	Nankong	Ammonia Plt. to Produce Urea	260 tons	.....	Design Stage	1956	Vulcan	NH_3-Hydrocarbon Urea—Vulcan	Hydrocarbon
AUSTRALASIA									
Australia									
Petroleum and Chemical Corp.	Silverwater	Petrochemical Plt.	.....	$7,000,000	Planned	Dec., 1955	.....	Power-Gas Corp. (Aust) Pty., Ltd.	Power-Gas Corp. (Aust) Pty., Ltd.
Socony-Vacuum	Altona	Alkylation Unit	1,700 bbls.	.....	Planned	Aug., 1956	.....	Kellogg	KIC
*Standard-Vacuum	Melbourne	Alkylation	.....	.....	Under Constr.	Dec., 1955	.....	Braun, Soc.-Vac.	Braun
Phillipine Islands									
Edgington Oil Ref.	Manila	Asphalt Plt.	.....	$3,000,000	Planning	.....	.....	.....	.....

* First appearance in tabulation † Added capacity

NOTE:

Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Austin—Austin Co.
Badger Mfg.—Badger Manufacturing Co.
E. B. Badger Ltd.—E. B. Badger & Sons Ltd.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Breda—Breda Electromaccania Locomotive
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Cat. Constr.—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
Consd. Eng.—Consolidated Engineering Company
Craig—A. F. Craig & Co.
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services, Inc.
E&A—Ehrhart & Arthur, Inc.
Esso R&E—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M.B. H.
Etabadger S.A.—Etablissement Badger, S.A.
F&C—Farnsworth & Chambers Co., Inc.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—The Girdler Co.
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graff—Graff Engineering & Equipment
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineraloel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P A—Kellogg Pan American
KIC—Kellogg International Corp.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Lummus—The Lummus Co.
Macco—Macco Corp.
Mannix Gill—Mannix Gill, Ltd.
McKee—Arthur G. McKee Co.
M-C & S—Merritt-Chapman & Scott Corp.
Olsen—O. L. Olsen
P. A. HydroRes—Pan-American Hydrocarbon Research Co
Parker—Parker, Steffens & Pearce
Parsons—The Ralph M. Parsons Co.
Petco—Petroleum Engineering Tool Co.
Phillips—Phillips Petroleum Co.
Pritchard—J. H. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Refinery—The Refinery Engineering Co.
Rust—Rust Engr. Co.
SD—Scientific Design
S & B—Sirgmaster & Breyer Separator-Nobel Co.
Soc. Vac.—Socony-Vacuum Oil Co.
Southwestern—Southwestern Constr. Co.
S.O.D.—Standard Oil Development Co.
Sohio—Standard Oil Co. of Ohio
Stearns-Roger—Stearns-Roger Mfg. Co.
Sunland—Sunland Refining Co.
S & W Badger Div.—Stone & Webster Engineering Corp. Badger Process Div.
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Sweco—Southwestern Engineering Co.
Tears—Tears Engineers
Tecnider—Tecnica Idrocarburie Derivati
Tellepsen—Tellepsen Construction Co.
Texaco Dev.—Texaco Development Corp.
Texaco—The Texas Co.
Texas Natural—Texas Natural Gasoline Corp.
Treco—Refinery Engineering Co.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.
J. G. White—J. G. White Eng. Corp


CORROSION FACTORS
HIGH TEMPERATURE WORK SHEET
Date
1. PROCESS OR OPERATION: (e.g., heat treating, vitreous enameling, hydrocarbon reactions, etc.)
2. HEATING PRACTICE: Analysis of fuel
Temperature °F. or °C. Maximum
Average
Standby
Time at temperature
Rate of heating
Method of cooling (e.g. furnace cool, oil quench, etc.)
Frequency of heating and cooling
Magnitude of operating stress
Type of stress (e.g., static, fatigue, impact, etc.)
3. ENVIRONMENT: Chemical composition of atmosphere, fused salt, molten metal, etc. in contact with metal surface
In the case of an atmosphere, give dew point
Concentration of sulfur compounds, if any, preferably in grains sulfur per 100 cu. ft. of
EQUIPMENT
4. EQUIPMENT OR PART: (e.g., radiant tube,
5. METAL OR ALLOY OR OTHER MATERIAL USED:
6. DIMENSIONS: Size and thickness of rod, sheet, plate
EXPERIENCE
7. SERVICE LIFE OF MATERIAL USED:
8. TYPE OF FAILURE: (e.g., cracking, sagging, general

When you need suggestions on a specific high temperature problem...

The High Temperature Work Sheet has been designed to make it easy for you to outline your problem as completely as possible and to make sure no significant factors will be overlooked. The completed form will assure your receiving information most applicable to your particular requirements.

Use this Work Sheet as a convenience in stating your problem in the event that you:

1. Are undertaking a new process involving the possibilities of corrosion at temperatures with which you have not had operating experience.
2. Wish to compare the performance to be expected from other metals and alloys with that of materials previously used and found satisfactory.
3. Require a substitute for an alloy or material at present not readily available.

Fill in and return this coupon.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y. PR 10-55

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name_____ Title_____

Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

Oil Sampling Accidents Can Be Prevented

Adopt these methods and you will keep down the number of injuries of those who draw off refining plant samples.

THROUGHOUT the oil industry, and particularly in refineries, the drawing of thousands of samples a day results in numerous personal injuries. Petroleum products or cuts which are irritating to the flesh, corrosive acids and caustics which eat into the flesh and hot oils which burn the flesh are the problems.

One large refinery recently submitted to the National Safety Council, Petroleum Division, the accompanying sketches of sampling devices which should go a long way toward preventing splashes and burns to samplers of hot oils.

Specifications for sample bottles and cans, measured in the light of the best accepted safety practices, were listed as follows:

(1) Glass bottles should not be used for sampling of materials over 180° F. temperature.

(2) Never use palm of hand to force cork into bottles.

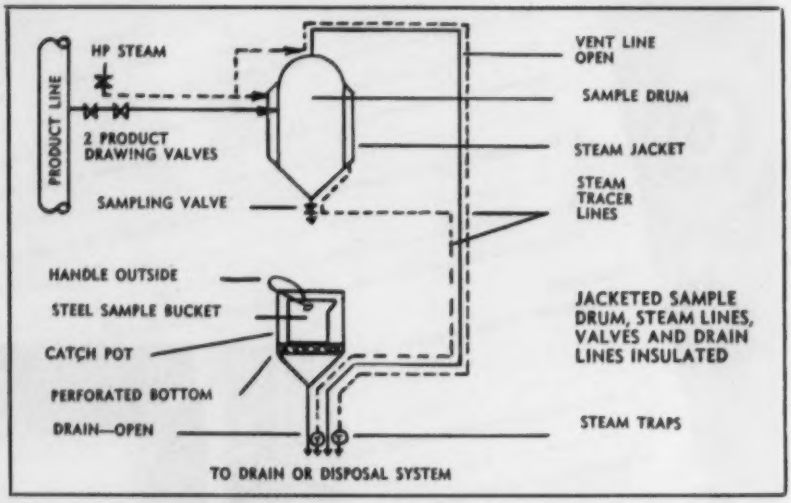
(3) Use metal cans for materials over 180° F. temperature.

(4) Never run material into metal cans when the temperature is in excess of 350° F.

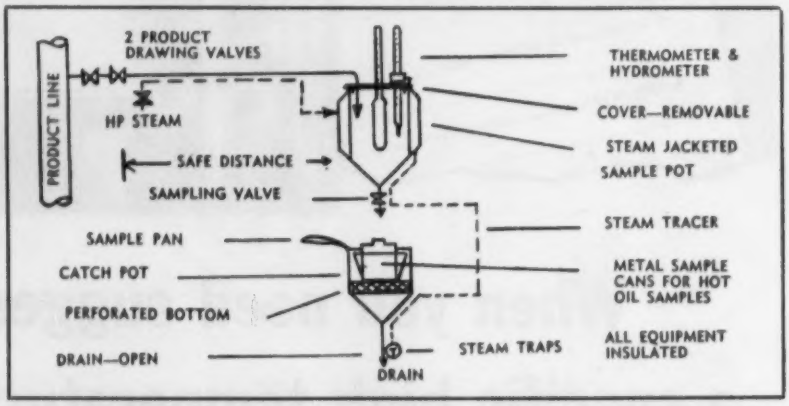
(5) Carry all sample bottles or cans in buckets or sample carriers.

In addition, there are three items of general precaution that should be carefully followed:

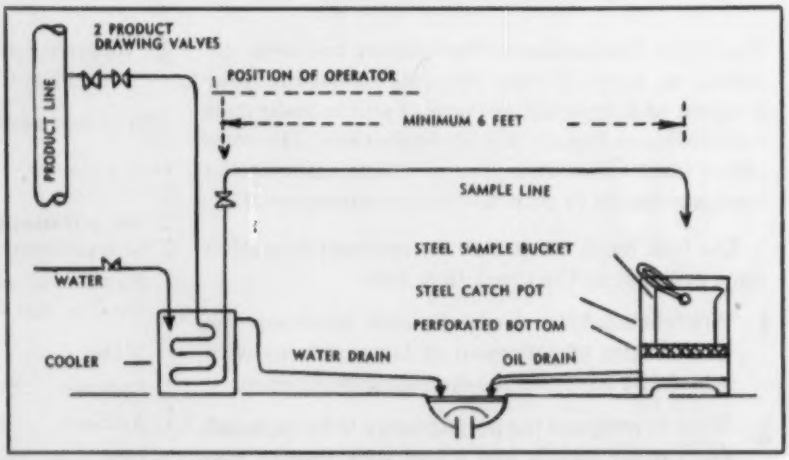
- Protect your eyes with goggles.
- Protect your face with a face shield.
- Keep your sleeves down and under the gauntlets of your gloves.



Sampling devices—No. 1. Hot oil that solidifies at normal temperatures.



Sampling devices—No. 2. Combination sampling and gravity device for hot oil that solidifies at normal temperatures.



Sampling devices—No. 3. Hot oil that does not solidify at normal temperatures.

TO MAINTAIN HIGH PRODUCTION

AND REDUCE DOWN-TIME...

ESSO installs 7,956 Anaconda Cupro Nickel, 30%-702 Tubes in condensers and coolers at Bayway Refinery

This condenser is used in the No. 1 Fluid Catalytic Cracking Unit at the Bayway Refinery of Esso Standard Oil Company at Linden, N. J. The unit produces about 25,000 barrels of petroleum products daily—ranging from high octane gasoline to heating oils.

7,956 ¾" Cupro Nickel, 30%-702 Tubes were supplied by Anaconda for the condensers and coolers of this cracking unit. On the shell side, these tubes are subjected to temperatures as high as 550°F at 75 PSI by process streams containing both sulfur and salt compounds. On the tube side, the summer salt water temperature ranges from 80°F at the inlet to 110°F at the outlet.

Information gathered from test runs within the refinery indicates these ANACONDA Cupro Nickel, 30%-702 Tubes have a life expectancy in this service of from 6 to 12 times greater than tubes made of Admiralty Alloy.

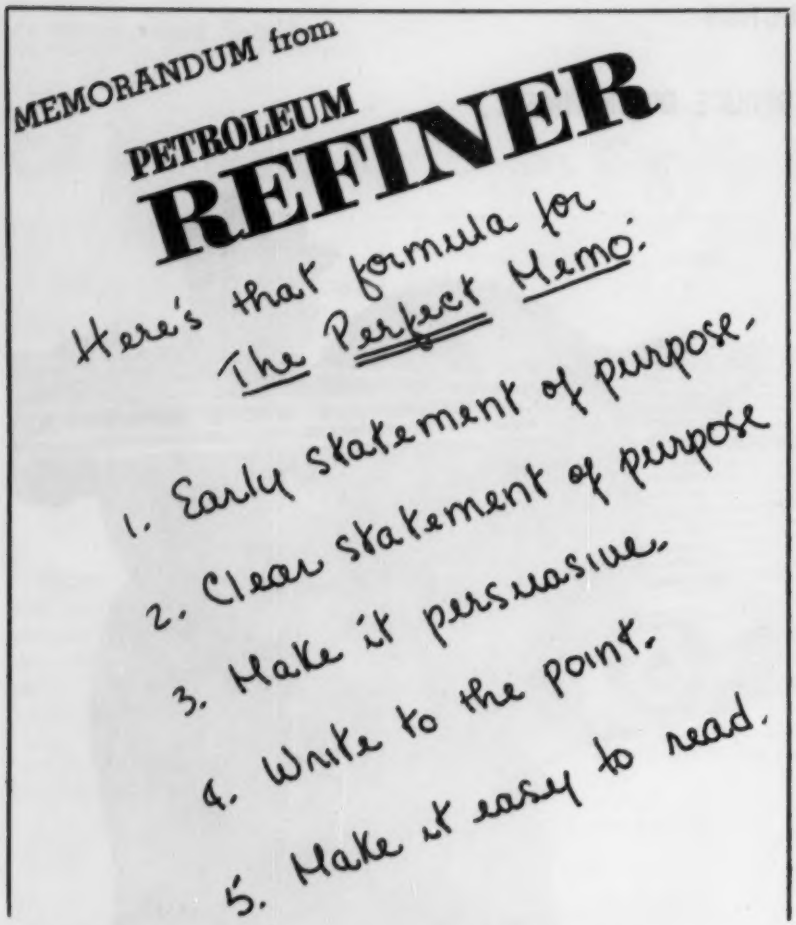
ANACONDA Cupro Nickel, 30%-702 Tubes are recommended where process liquids, vapors and cooling waters are corrosive—particularly where temperatures are too high for other copper alloys. Tubes of this alloy also have superior resistance to sea water at high velocities. They have good physical properties at elevated temperatures and resist stress-corrosion cracking.

Our files bulge with a collection of tube performance case histories that can answer many of the corrosion problems you face. We can put the information in these files to work for you at once—to help you select the one best alloy for your job. Write, outlining your operating conditions, to Dept. TD, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass, Ltd., New Toronto, Ont. 64111

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

For more data on advertised products, use Readers' Service Cards, last page.



Auren Uris,
Research Institute of America

THERE'S A SUREFIRE formula for writing effective memos.

Just one hitch: you have to work it out for yourself:

That's not to say that one of these clever writer chaps couldn't give it to you in a couple of neat paragraphs. But it just wouldn't be the same. It would be his, not yours.

Investment With a Future

It's worth your while to make the small investment of time and effort needed to develop an answer to the memo-writing problem. The memos you write do two things for you:

- They help create the impression, either for good or bad, you make on your associates.
- Your memos are a major means of integrating you and your efforts into total company activity.

There's one point that ought to be made at the outset: memo writing is one activity where quantity doesn't necessarily mean quality. Take this case, for example:

Executive A never writes a memo to anybody about anything. Executive B's outbox is piled mountain high with correspondence aimed up and down the line.

Yet the second executive may be doing just as poor a job "putting himself across" with the receivers of his mail as the non-sender. In short, "doing it" isn't enough. It's doing it well that pays off.

Working Out the Formula

Here are the steps that lead you down the road to better memos, the heartfelt thanks of all your correspondents, and the satisfaction of a greater mastery of an important management skill.

1. Gather a sample of inter-office memos you've received recently. If you like, ask your secretary to do it for you. If your correspondence is filed as it comes in, ask your secretary to accumulate the memos that come your way for the next few days. Anywhere from 6 to 20 pieces of correspondence will do the trick.

2. Separate the bad ones from the good ones. Go through the memos you've accumulated, dividing them into two piles. In one pile put all the memos that you feel are poorly written, those that, for one reason or another, you *don't* like, those that make difficult or dull reading. This is your "N. G." pile. Into the second pile go the "O. K." memos—those you feel do the job for which they were intended.

Disregard content at this point. You may find, for example, that in one communication, the boss has called you down. If you can admit, however grudgingly, that his memo is well-written, it still goes into the *O. K.* pile.

3. Analyze the qualities that make for a poorly written memo. You may find that some memos have qualities that are obviously undesirable. The quality of verbosity, for example, is easy to spot. But of course there are other possible drawbacks besides that of using a dozen words where one word will do. Keep on going through the group of memos and note on a sheet of paper each quality that you find objectionable.

One executive, after following this procedure, was able after 15 minutes of analysis, to come up with the following list of *undesirable memo characteristics.*

No clear idea of memo purpose—The item in which this characteristic was observed started off with a rambling discussion of the necessity for cutting costs. After six paragraphs of this, the writer then stated the memo purpose—an idea he had for improving an office procedure.

Overload of big words and stilted phrases—"I am of the opinion that it is highly desirable to create an early liaison between sales and production on this vital matter. Ultimate considerations should be taken up," etc., etc.

Unattractive "hard to read" appearance—two pages of single-space typing all in one sentence.

No purpose, but an ulterior motive—This quality was contained in a memo that was really only a sounding board for the writer to express his gripes and complaints.

4. Spot the qualities that make for a well-written job. Proceed in the same manner to go through your "O. K." pile. In some cases you may not be able to decide off the cuff ex-

Phantom illustration of Chapman's New Internal Type Check Valve showing how tilting disc valve mechanism is completely enclosed within pipe.

NEW

At this point in natural gas transmission line, a 24" Chapman Internal Type, tilting disc, check valve is installed. Note the simple, welded construction. No bolted gasket joint . . . no maintenance necessary. No reducers in line . . . on easy, low cost installation.

The INTERNAL Type CHAPMAN

Tilting Disc Check Valve for pipeline use

1. Eliminates the use of bolted gasket joint

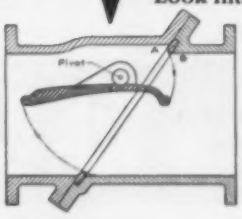
2. Greatly reduces the cost of valve and installation

3. Retains the low head loss of Chapman Tilting Disc Construction

4. Weighs far less...therefore requires less support

Chalk up another first for Chapman. It's the *New Internal Type* Chapman Check Valve for transmission pipeline use. Into a section of pipe supplied by the purchaser, Chapman welds the complete working mechanism of a Tilting Disc Check Valve, thus providing a Check Valve unit with no bolted gasket joint and eliminating the necessity of reducers in the line. It's lighter in weight, lower in cost, easier to install, yet retains all the advantages of Chapman's Standard Tilting Disc construction: low head loss . . . a quick, quiet, tight closure . . . no slamming . . . no jarring . . . no opening of joints or wear of moving parts. Discs are faced with 12-14 Chrome Stainless, Malcomized to 900 Brinell minimum for maximum wear resistance. Available in sizes 16" and larger diameter of pipe opening.

Look into the possibilities of this *New Internal Type* Chapman Check Valve. It's available for a maximum pressure of 1200 p.s.i. cold, oil or gas. Write for complete information *today*.



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc lifts away from the body seat when opening, and drops into contact when closing, with so sliding or wearing of the seats.

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.

Follow-thru service makes Ansul Sulfur Dioxide your best buy

Your order for Ansul liquid sulfur dioxide includes more than the product, it includes a good measure of service—the kind of service that starts before the chemical is delivered and then goes on and on. We call it follow-thru service.

From the first meeting with your Ansul representative, 40 years experience in the application and handling of liquid sulfur dioxide becomes available to help solve your particular problem. Very often, shipping and handling details worked out with the Ansul representative result in dollar savings. On-the-spot application assistance is, of course, always available when you feel it is needed.

For example, over the years we have been privileged to work with a number of petroleum processors employing the Edeleanu Process. This experience in the field of sulfur dioxide aromatic extraction is at your disposal.

When you order Ansul liquid sulfur dioxide, you can be sure of product purity, dependable delivery and all the service assistance you require. Write for more information. ANSUL CHEMICAL COMPANY, Dept. C-69, Marinette, Wisconsin.

ANSUL

actly why you find a particular memo easy or pleasant reading. You may have to do some thinking about the individual pieces.

Qualities of Well-Written Memo

After you've gone through your "O. K." correspondence, you may find a list of desirable qualities that looks something like this:

Early statement of purpose
Clear statement of purpose
Persuasive
Businesslike, to the point
Easy to read
Well organized

Don't Start Writing Yet

Now that you're up to this point, you've completed more than half the job of developing your personal memo writing formula. But hold on. You've still got a little distance to go before you can switch on the dictating machine and say, "Miss Smith, take an inter-office letter."

It's the "how-to-do-it" element that's still lacking.

By compiling your list of *undesirable* memo qualities you are now aware of how *not* to write a memo.

By compiling your list of desirable memo qualities, you have a pretty good idea of the basic prerequisites. Now it's necessary to work out the implementation. You want to master the mechanisms involved in working the desirable memo characteristics into your own memo-writing style.

Building "The Perfect Memo"

Some of the points are obvious. Now that you've indicated by your own reactions that it's desirable to have an "early statement of purpose" in an inter-office memo, there's little question as to how to accomplish this end.

But for the sake of completeness, let's go down the list item by item and work through the points involved.

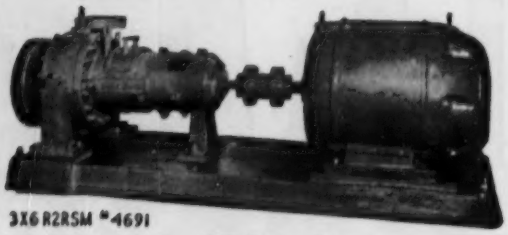
Early statement of purpose—"Early" doesn't mean in the first sentence, but it should mean in the first paragraph. Let's say, for example, that you want to tell your superior that one of your customers is about to send in an order that will require special attention. Your first paragraph might read: "In a phone conversation with Ed Jones this morning, he told

NEW
SPEEDY MAKE OR BREAK
for those "hard-to-get-at places"!
CATAWISSA
4 Star
HAMMER TYPE
LUG NUT UNIONS
with CATAWISSA'S EXCLUSIVE
PERFECT SEAL
and 3-to-1 SAFETY FACTOR
2" to 4" sizes
REGULAR OR DOUBLE-START ACME THREADS
FAST
INTER-CHANGEABLE PARTS
SELF ALIGNING
SAFE
AN EFFICIENT TIME AND TOOL SAVER
for dependable, trouble-free service!
Now available in 2" to 4"-sizes (inclusive), Catawissa 4-STAR LUG NUT UNIONS incorporate an exclusive combination of both lug and hexagonal shaped nuts with regular or Double-Start Acme threads for speedy make or break with either HAMMER OR WRENCH! The Catawissa Lug Nut design provides more striking surface—a straight, flat surface that eliminates the chance of a damaging, glancing hammer blow!
New Catawissa 4-STAR LUG NUT UNIONS are hot forged from solid steel bars, conforming to A. S. T. M. Spec. A-105, grade 2. Exclusive PERFECT SEAL seat design gives safe, sure, leakproof joints even with the pipe not in perfect alignment.
SEE THEM, BUY THEM – AT YOUR LOCAL DISTRIBUTOR
CATAWISSA VALVE & FITTINGS COMPANY
CATAWISSA • PENNSYLVANIA
THE MOST COMPLETE LINE OF UNIONS ON THE MARKET . . . REGULAR OR SPECIAL
CATAWISSA FORGED STEEL UNIONS
TAKE THE GUESSWORK OUT OF UNION REQUIREMENTS

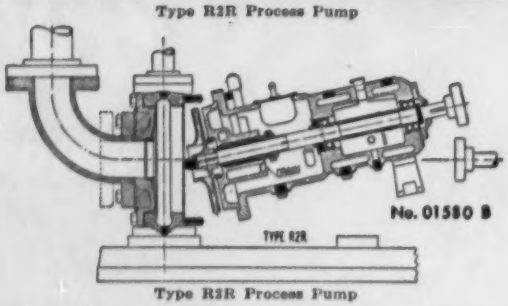
For more data on advertised products, use Readers' Service Cards, last page.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

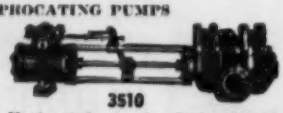
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump.



3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids.

4043 AA
Pedestal Mounted Centrifugal Pump.

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump.

4728
Double Pedestal Bearing Centrifugal Pump.

3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type.

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

As Management Sees It . . .

me that he's considering a re-order of our XL-50 material. He'll let us know by the end of the week, but I'd like to remind you that placement of this order will mean . . ."

Clear statement of purpose—This seems like a pretty obvious point, but actually it's one with which many executives have trouble. "My department has been having considerable difficulty with deliveries," one executive writes. And then he goes on with a general discussion of the transportation problems that have hampered his operation off and on over the past years. What's the "purpose" of this memo? Is the executive going to suggest holding conferences with the carriers or is his idea to change the means of transportation?

A "clear" statement of purpose means a simple and specific statement that will explain why this particular memo is being written at this particular time:

"I would like you to O. K. the extra expense involved in having a direct messenger service for small shipments from local suppliers."

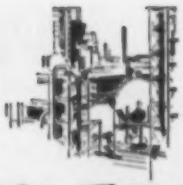
Persuasive—Frequently you'll write a memo to get someone to go along with an idea or a course of action. Your correspondent may be anyone in or outside your organization. But the art of being persuasive by means of the written word is somewhat different than the oral effect. The matter of being persuasive, of course, is a subject all by itself. In connection with written memos however, there are two points to keep in mind. You can get people to see things your way by these two means:

a. Paint the objective you're trying to achieve in attractive terms: "I feel this idea, if properly worked out, could be the solution to a problem that has ben a headache to all of us. In your own case, for example, it would mean that you'd be rid of the nuisance of supervising six people by 'remote control' . . ."

b. Support your statements or arguments by facts that tend to back up or prove your contention: "A similar move was made by the ABC Company one year ago. In this twelve-month period they have achieved the following results . . ."

Business-like to the point—Don't confuse this quality with brevity. You could write a 1000 page report that

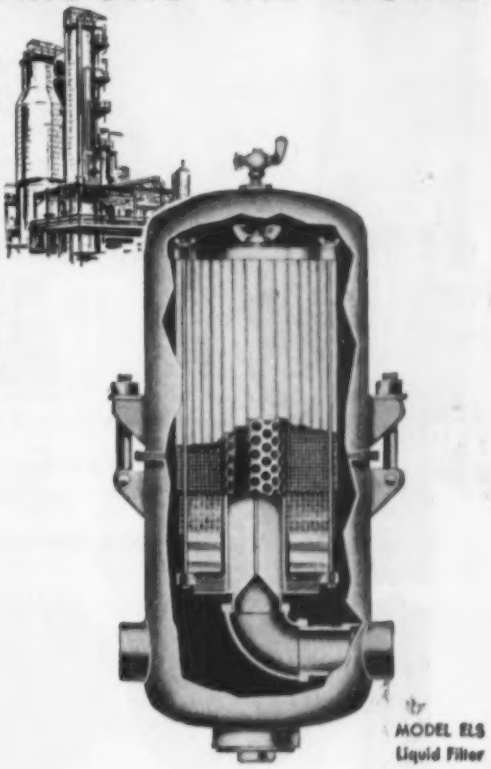
VERSATILE STAYNEW LIQUID FILTERS



For Oils, Water, Chemicals, Coolants

SOLVE FILTERING PROBLEMS AROUND THE WORLD

PRACTICALLY any liquid can be efficiently and economically filtered by a Staynew Liquid Filter. They are designed for adaptation to virtually any space requirement or any arrangement of inlet and outlet connections. All known types of filtering media are available to provide any degree of efficiency for any specific problem, or for use regardless of temperature, pressure or corrosion requirement. All units can be constructed according to the API-ASME and the various ASME Code specifications. Staynew Model ELS liquid filters are available in many types of materials other than regular steel, such as stainless steel, monel, herculoy and other non-corrosive materials.



MODEL ELS
Liquid Filter

PARTIAL LIST OF LIQUIDS THAT CAN BE FILTERED BY STAYNEW LIQUID FILTERS

Acetone	Emulsions	Molasses
Acids	Enamels	Naphtha
Adhesives	Ethanolamine	Paint
Alcohols	Ethylamine	Pharmaceuticals
Alkalis	Extracts	Propylene
Ammonia	Flameproofing Solutions	Quenching Oils
Asphalt	Fuel Oil	Resins
Benzene	Furniture Polish	Rubber Cements
Benzine	Gasoline	Sizing
Beverages	Glue	Soap
Butane	Greases	Solvents
Casein	Gums	Steam Condensate
Castor Oil	Hydraulic Fluids	Syrups
Caustic	Ink	Tar
Cellulose Solutions	Kerosene	Turpentine
Chlorine	Lacquers	Varnish
Chocolate	Latex	Vegetable Oils
Cleaning Fluids	Liquid Paraffin	Viscose
Coating	Lubricants	Water
Coolants		Wax
Cutting Oils		

SEND for this 12-page bulletin D-IL containing specifications, engineering and performance data, photos and descriptions of recommended types of filter media, check list of liquids that can be filtered and other helpful data.

DOLLINGER PROTECTS YOUR STAYNEW FILTERS

Representatives in Principal Cities

DOLLINGER CORPORATION

47 Centre Pk., Rochester 3, N. Y.

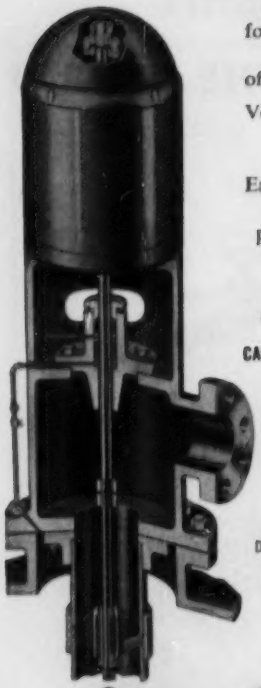
ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

Verti-Line
CLOSE-COUPLED PUMPS
for every Industrial Vertical Pump Installation

The Verti-Line Close-Coupled Pump is not just another deepwell pump adapted to industrial service. It is designed and engineered for such jobs as booster service, fire protection, cooling, transfer and general service pumping of water and other fluids, corrosive or non-corrosive.

Verti-Line Pumps are made to the highest standards of quality in workmanship and materials to assure a *precision built* product. Each unit is thoroughly tested and rigidly inspected, insuring ease of field assembly and perfect performance—guaranteed to meet the most exacting specifications.

Whatever your vertical pump needs, investigate Verti-Line Pumps before you buy.



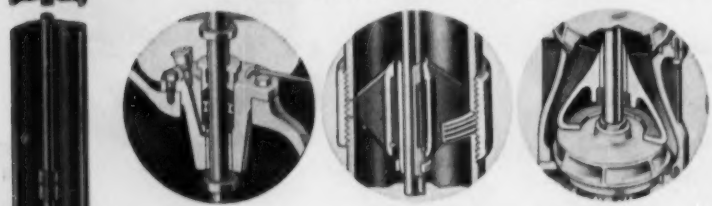
CAPACITIES FROM 20 GPM TO 30,000 GPM — HEADS TO 600 PSI

Heavy-Duty Fabricated Discharge Head With Solid Shaft Motor

In-Line "T" Type Fabricated Discharge Head With Hollowshaft Motor

Standard Discharge Head With Combination Gear and Motor Drive

TYPICAL CONSTRUCTION FEATURES
(Open lineshaft type . . . Enclosed lineshaft also available)



The packing assembly is simple and effective. It is easily accessible and consists of a packing container, lantern ring, packing rings, pressure relief bushing, gland, fluid by-pass and lubrication fittings. Mechanical shaft seals also available.

Outstanding feature of bearing assembly is removable stainless steel shaft sleeve. This prevents shaft wear and bearing journal corrosion, and is easily replaced without special tools. You simply remove the old and slip on the new which is secured by a stainless steel collet.

Dual bowl bearings of rubber and bronze are supplied in most open and enclosed lineshaft pumps. Extra stability and resistance to abrasives mean longer life.

Send for your free copy of our new booklet, "Pumps for Sale." Ask for Bulletin T-105

Verti-Line Pumps are the exclusive products of
LAYNE & BOWLER PUMP COMPANY
general offices and main plant
2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

As Management Sees It . . .

would still be business-like and to the point. This quality can be summed up in a single word: *"relevancy."* As long as what you're saying bears on the basic purpose of the memo, you're on the beam.

Easy to read—This quality can be built into a memo in several different ways. There's no hard and fast rule, but here are some of the points to keep in mind:

a. Interest—Material can be either inherently stimulating or dull as dishwater. If you're describing how something happened, for example, you're in effect telling a story that in the average case will be able to sustain your reader's interest. You're in a less fortunate position, however, if what you're writing about centers on a mass of monotonous data.

b. Brevity—Generally short words make easier reading than long ones. Ditto short sentences. Ditto short paragraphs.

c. Well-organized—Frequently you can spot this quality at a glance. You examine one memo, and it looks like a solid block of typing. You approach the task of reading it with the same resignation as the explorer, machete in hand, confronting a dense jungle.

The well-organized memo, on the other hand, is as attractive as an open sunny field. And as a matter of fact, in the way a well-organized memo is laid out—in its precision and neatness—it has some of the qualities of neatly fenced-in countryside. Here are the specific points that make for good organization:

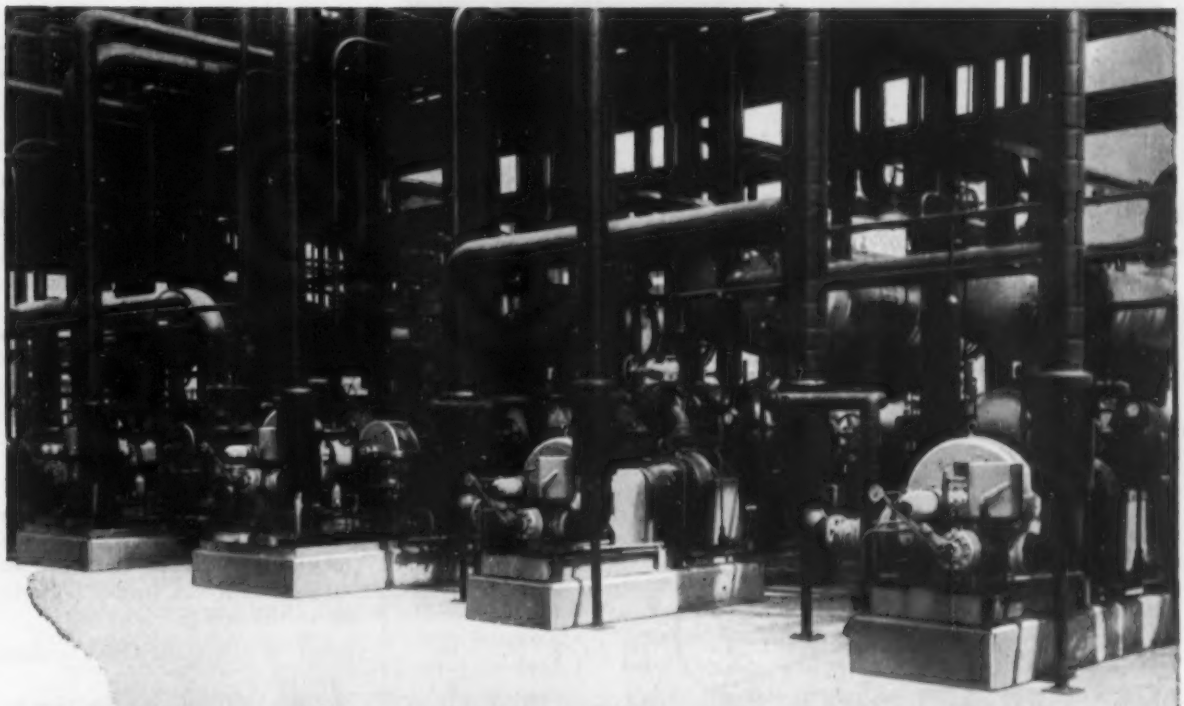
Title—Even if your inter-office form doesn't have the printed work "subject" at the top, there's no reason for you not to add it. Here are a couple of examples:

Subject: Vacation Schedules for the Maintenance Department.

Subject: Suggested Agenda for St. Louis Meeting.

Main headings—The average memo lends itself to division into two or more main sections. Here, for example, are the main headings used in a memo discussing a grievance case: Background; The Grievance Incident; Developments in the Handling of the Case; Present Situation.

Incidentally, in this connection, the lives of many executives have been made a lot easier by their secretaries. Your secretary may very well be able to make constructive suggestions as to



Elliott—the turbine you'll see all over

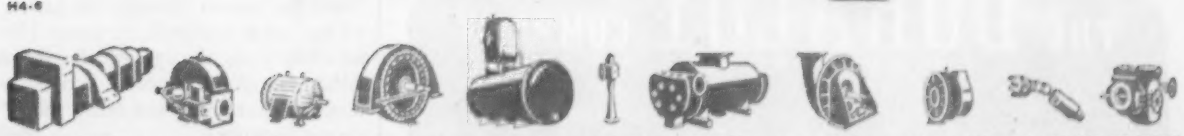
. . . the Richfield Oil Corporation's new Los Angeles, Calif. refinery

● The Elliott YR turbines in the photo above are just a few of many all over this up-to-the-minute "cat-cracker." Scores of them, ranging in sizes from 2 hp to 600 hp, are on the job driving process and water pumps, fans and compressors.

Elliott YR mechanical drive turbines are perfectly at home in refinery service. Their reputation for dependability has been earned by thousands of successful installations. Although maintenance requirements are simple, users like the ease of inspection, accessibility of wearing parts, and the interchangeable components. Bulletin H-22 gives complete details. Write Elliott Company, Steam Turbine Department, Jeannette, Pa.

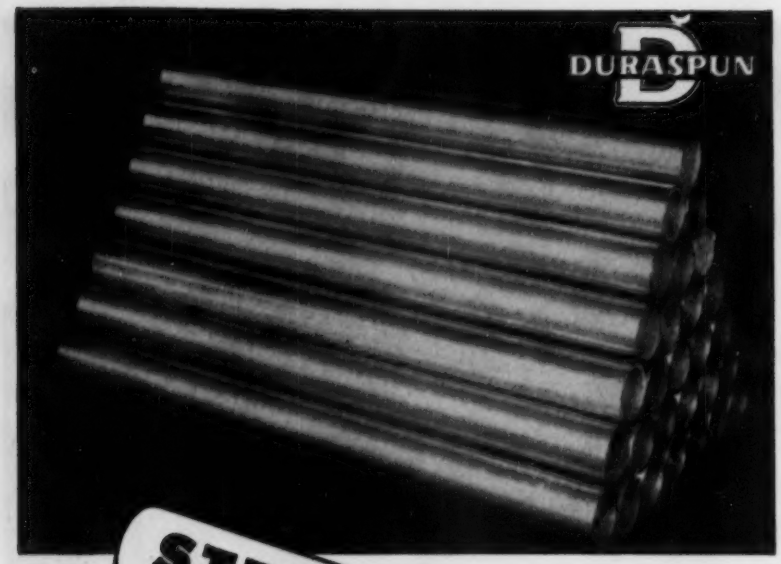
ELLIOTT Company

H4-6



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

For more data on advertised products, use Readers' Service Cards, last page.



STRONG

is the word for **Centrifugally Cast** Pipe

. . . and the alloying is selected so that you will get high resistance to corrosion or high resistance to extreme heat or high resistance to both, as you require.

Centrifugally Cast Pipe has been a major DURALOY item since 1933 when we pioneered such high alloy castings in this country. Standard pipe production is in the following classification:

Outside Diameter	Minimum Wall	Length
2½" to 3"	1/4"	88" maximum
3" to 6" inclusive	5/16"	110" maximum
Over 6" to 12" inclusive	3/8"	168" maximum, 24" minimum
Over 12" to 14" inclusive	7/16"	168" maximum, 24" minimum
Over 14" to 20" inclusive	1/2"	180" maximum, 48" minimum
Over 20" to 24" inclusive	1/2"	88" maximum
Over 24" to 32" inclusive	5/8"	80" maximum

RESISTANT

is the word for **Chrome-Nickel** Alloying

The strength of Centrifugally Cast Pipe comes largely from the exceptionally uniform dense grain structure.

If you require a gas or liquid pipe line or a process tube requirement calling for high strength plus high resistance to corrosion and/or temperatures in the piping, DURALOY Centrifugally Cast Pipe will meet your specifications with complete satisfaction. This is the record of our castings in industry for many, many years.

THE DURALOY COMPANY

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

As Management Sees It . . .

the positioning of headings and subheads.

Using the Formula

There you have it—your personal formula for effective memo-writing. The basic approach, of course, has been to get you to analyze what it is about the memos you *receive* that you find particularly desirable, and to incorporate these qualities into your own memo style. It's simply an application of the golden rule—you'll be doing unto others what you'd like them to do for you.

Testing Your Effectiveness

The question of *content* comes up in connection with the memos you write. The checklist below can help you analyze your memo writing performance on this point:

1. Do your people often have to check you for—
   a. additional information (for example, to supplement a report)?
   b. clarification of a communication you've sent them?
2. Do your subordinates complain that they get information late?
3. In communicating with your superior—
   a. do your replies to his reports or memos tend to be late?
   b. do you have to call him on the phone to give him additional information that should have been included in the memo?
   c. does he have to contact you for an explanation of your memos?
4. In your communications with fellow executives—
   a. are you handicapped by persistent gaps in information?
   b. are you sending any routine memos that no longer fill a purpose?
   c. do you know of any change in method of communications that would improve results (e.g., switching from memos to conferences)?

Finally, keep in mind that you have available to you a gold-mine of information about your memo-writing practices. Just check through the carbons on the last ten memos you wrote. How do they stack up against the list of "desirable characteristics" you developed by examining the other fellow's correspondence? ##

For more data on advertised products, use Readers' Service Cards, last page.

FP *complete process instrumentation*

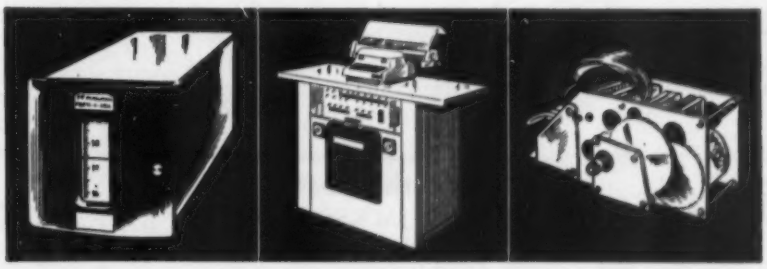
The age of machines that think is here! *The Automatic Logger — developed by Fischer & Porter — is an automatic, high-speed means of scanning masses of heterogeneous information, interpreting it, and making possible a compact report of essential data. A practical step towards complete automation, its industrial applications are numerous.*

The F&P Automatic Logger has broken the time barrier that formerly existed between the measurement of data and its conversion into usable form. Costly, time-consuming manual data handling, and the inevitable possibility of error involved, is now eliminated. This system produces more reliable data in only seconds' time.

Using a single high-accuracy transducer, the F&P Automatic Logger can simultaneously scan, measure and record as many as 200 variables. By converting the measurements into digits, the readings may be recorded as a typewritten column log sheet or as punched tape. Abnormal readings are printed in red—and also may be alarmed. The punched tape can be fed into a tape-to-card converter for automatic computing, or, where a log is not required, the data can be fed directly into computers or punch-card equipment for computing, accounting or control.

F&P Automatic Loggers are currently being used in oil refineries, in chemical, aircraft, and glass plants, and in many research and test facilities to increase production and lower operating costs. Each system comes ready for pneumatic and electric connections — and for your assurance, is fully tested, fully guaranteed.

Fischer & Porter manufactures various other data reduction and automation equipment, such as the Package Recognition and Inventory System, ready made for immediate installation in manufacturing or processing plants. To find out how time-saving data reduction or automation equipment can save money in *your* plant, get in touch with us—no obligation.



Press-I-Cell Pressure Instrument | Automatic Logger | Digi-Coder

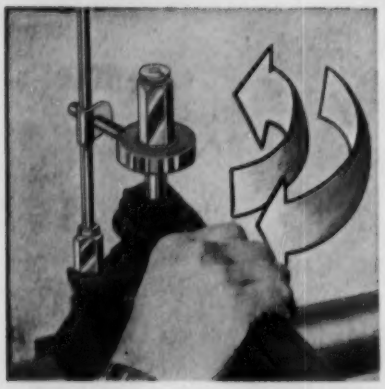
FISCHER & PORTER COMPANY

COUNTY LINE ROAD • HATBORO 9, PA.

Measuring, recording and controlling instruments
Centralized control systems
Data reduction and automation systems
Chlorination equipment
Industrial glass products

Sales offices in 32 American cities and in principal cities abroad

This OPENING and CLOSING motion....



LUBRICATES
your plug valves
AUTOMATICALLY
when you equip with....

DELTA
AUTOMATIC
PLUG VALVE
LUBRICATOR

Engineers agree that plug valves should be lubricated each time they are opened and closed.

NOW they can be—automatically—by the adoption of this simple, fool-proof device, that never forgets.

Each time the valve is opened and closed a measured amount of lubricant is forced in. The reservoir holds enough lubricant for the valve to be opened 50 to 80 times, and is refilled in seconds with the Delta Gun.

The savings in time, trouble and valves will repay the small cost of this Delta Lubricator again and again. Write for details and prices.

The Only Complete Plug Valve Lubrication Company

DELTA ENGINEERING SALES CO.
804 Louisiana Ave. Shreveport, La.
Sales Offices in All Principal Cities

DELTA-DESCO
PLUG VALVE LUBRICANTS AND EQUIPMENT

LUBRICANTS FITTINGS GUNS LUBRICATORS

As Management Sees It...

To Meet Engineer Shortage: Utilize Them!

Time clock punching or hourly wage basis are out of the question for the engineer who is a professional and wants to be treated as such.

Emmett G. Jackson,
The Lummus Company,
Houston

EVERY DAY we hear more about the shortage of engineers. Your job—utilize the ones you have!

Many companies are actually hoarding engineers—that is, they have competent engineers whose abilities are not being used to their fullest extent. These engineers are being used as draftsmen, clerks, and other non-engineering jobs that could be turned over to non-technical personnel. Engineers seem to lose perspective and morale when kept in jobs which can be done by people with less training. Let us see how we can get the most efficiency out of our engineers.

Engineers Punch Time Clocks?—In general, engineers are extremely individualistic and fiercely ambitious. They should not be typed with non-technical personnel because their functions demand concise, original thinking. They should not be required to punch time clocks, nor should they be paid on an hourly basis. Engineers do not readily take to unions because they had rather stand on their own ability than to share collectively in group benefits and become stagnated. In short, engineers are professional people and should be treated as such.

Engineers should be hired by engineers. Many companies make the mistake of leaving all the hiring up to their personnel department. A few years ago, the author, a civil engineer, was applying for a position with a large company. Pictures of reinforced concrete and structural steel buildings designed and constructed by the company were hanging on the walls, mute evidence of their previous projects. The personnel manager dismissed the application with a curt, "we do not use civil engineers." Not until some time later did the author realize the personnel manager did not know that civil engineering encompassed structural design as well as surveying. Only an engineer can properly evaluate the technical knowledge and ability of an individual after a short interview, and even he gets "taken in" occasionally by a smooth-talking "snow artist."

Engineers should have engineering titles. True, the term "engineer" has been greatly abused by the layman, but it still adds dignity to the company as well as the engineers when qualified personnel are referred to in a professional manner. It gives a man a feeling of pride to be associated with a company as an engineer rather than a checker, or squad boss. Also,

Meet the Author

EMMETT G. JACKSON is a senior design engineer in The Lummus Company's Structural department. He joined Lummus in 1951, after working for the Texas State Highway Department, first in the field and then in the Bridge division. He is a graduate of the University of Texas, where he received a degree in civil engineering in 1947.

ALUNDUM*

High-Purity Fused Alumina

How can you use it to advantage?

Among the many electrochemically refined materials produced by Norton Company, ALUNDUM fused alpha alumina is one of the most widely useful to industry. Thanks to its inherent properties of hardness, chemical stability and high density, engineers in various fields are finding many new applications for it.

Norton fused alumina is produced in a number of forms. Of these, 38 ALUNDUM* grain has proved particularly successful in applications demanding high purity. Electrically fused from Bayer-processed alumina, this white grain is shown by typical chemical analysis to be 99.49% pure Al_2O_3. It is insoluble in common solvents and extremely resistant to reduction. It is an amphoteric refractory and has high dielectric strength. Other characteristics include:

Melting point	**about 3600°F.**
Specific gravity	**3.94**
Crystal structure	**hexagonal system (rhombohedral division)**
Hardness	**9.0 Mohs' scale**
Index of refraction	**1.76 mean**

Typical Product Applications in which Norton high-purity fused alumina is now working out to advantage are:

For Catalytic Reactions. Norton fused alpha alumina carriers are outstanding for chemical stability and resistance to abrasion and erosion. Available in the form of spheres, rings and pellets they are used both in fixed bed oxidation reactions and as inert, low-density carriers for space filler applications where a low surface area (less than $1 m^2/gm$) is required. Other types of ALUNDUM catalyst carriers having surface areas in the range 5-60 m^2/gm are also available.

In Pebble Heaters. ALUNDUM heat exchange pebbles are giving excellent results in pebble heaters for heating gases above operating temperatures permissible in conventional tube furnaces. Their great resistance to abrasion, impact and repeated heating and cooling make them the ideal heat transfer medium in these devices. Also, their high refractoriness prevents them from the softening and "bridging" together that causes stoppages in the heater's moving bed.

In Thermal Cracking Reactors. Particularly in Wulff Process Generators for cracking light hydrocarbons to produce acetylene gas and Koppers-Hasche Generators for cracking light hydrocarbons to produce a variety of gases and petrochemicals — checkers made of Norton ALUNDUM high-purity fused alumina provide definite advantages. Their excellent heat transfer properties, high refractoriness and resistance to erosion caused by hot gases are important. Their ability to withstand the thermal stresses of intermittent operation assures long life. And their purity prevents side reactions with the reacting gases, thus safeguarding product quality.

In Gas Synthesis Generators. ALUNDUM fired shapes are ideal for lining generators of this type. Among the inherent characteristics of Norton high-purity fused alumina that work out very well are: high refractoriness, chemical stability, and inertness that prevents reacting with the contacting atmospheres.

Very many other uses for Norton high-purity fused alumina materials include: pure oxides and sintered refractories, refractory cements, wear-resistant parts, laboratory ware, coatings for rocket and jet plane parts and atomic energy equipment.

Other Norton Electrochemically Refined Materials

include CRYSTOLON* silicon carbide, MAGNORITE* magnesium oxide, NORBIDE* boron carbide, FUSED ZIRCONIA and many others, including a number still under development. These high-melting materials, which have varied applications in many fields, are also the basic ingredients of the famous Norton Refractory Rx's — refractories *engineered and prescribed* for the widest range of uses.

For Your Own Applications Or Developments

Norton Company not only supplies these materials in crude form, but has extensive facilities for processing and fabricating — and is ready to work with you in engineering materials to your particular requirements. A new booklet "Norton Refractory Grain — Electrochemically Refined" contains detailed information. For your copy, write to NORTON COMPANY, Refractories Division, 469 New Bond Street, Worcester 6, Massachusetts.

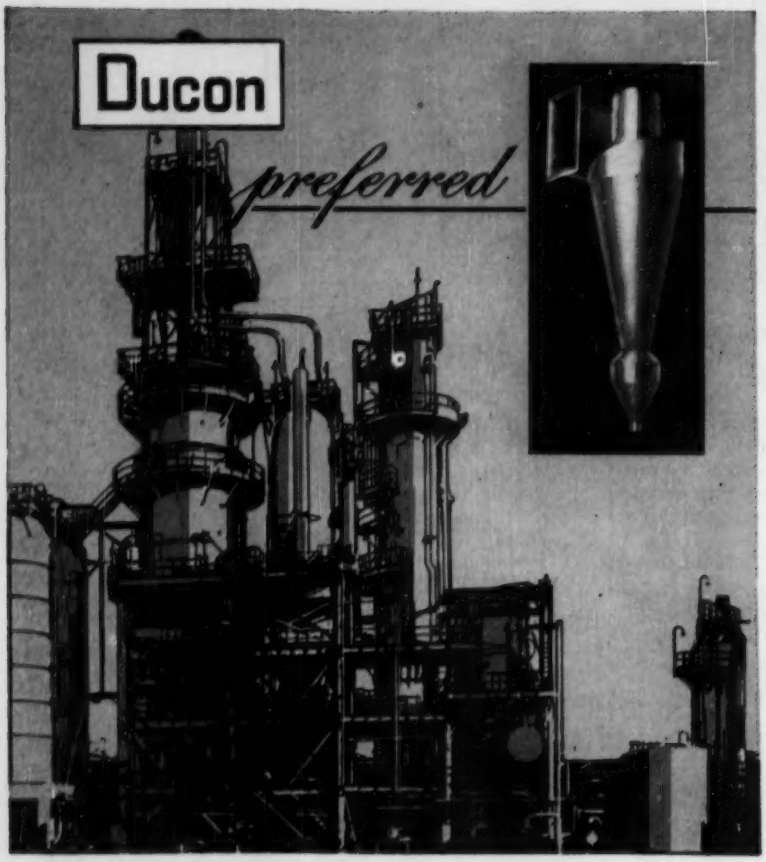
NORTON

REFRACTORIES

Engineered... Rx... Prescribed

Making better products... to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries



. . . for Catalyst Recovery in Leading Oil Refineries throughout the World

Ducon Type SDC Cyclones are specifically designed for high efficiency operation in petroleum refining processes such as:

- **Fluid Bed Catalytic Cracking**
- **Thermofor Catalytic Cracking**
- **Elutriator Towers**
- **Fluid Coking**
- **Fluid Hydroforming**
- **Catalyst Disposal and Conveying**
- **All Fluid Solid Operations**

Full descriptive literature on request

the name in dust control

THE **Ducon** COMPANY

Canadian Branch: THE DUCON COMPANY of CANADA, Ltd. 275 James Street North, HAMILTON, ONTARIO

147 EAST SECOND STREET, MINEOLA, N.Y. • Sales Representatives in Principal Cities

Designers and Manufacturers of Dust Control Equipment Exclusively

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

As Management Sees It . . .

sub-professional draftsmen have more incentive in their work when they realize that their future promotions will rank them with engineers.

Most companies encourage continued studies because it indirectly benefits the company as the engineer increases his knowledge. Where possible, full use should be taken of neighboring university facilities for training and consultation. If university facilities are not available, special courses can be sponsored by the company itself, and conducted by qualified engineers within the organization.

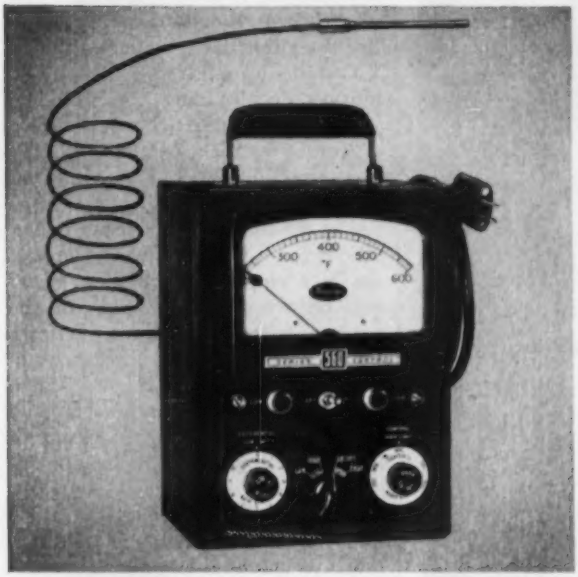
Many companies find it helpful to encourage their engineers to become registered, and to participate in the activities of professional organizations. Time off should be granted for registration examinations, professional meeting and seminars.

Money's Role for the Engineer—Some executives feel that an engineer's pre-occupation with money is a something-for-nothing attitude, and that it indicates the lack of professional attitude. However, men do not feel like professionals when they are paid less than skilled labor. On the other extreme, some companies depend on large salaries and fringe benefits to keep their engineers satisfied. A recent survey among engineers brought out the fact that they consider their future advancement and opportunities of greater importance than the items mentioned above.

Most engineers are concerned with how their employers like their work. Management should have a fixed engineer-evaluation system that is fully understood by their employes. Thus, the engineer's mind is at rest as far as his personal interest is concerned, and he can concentrate on the problems of his job.

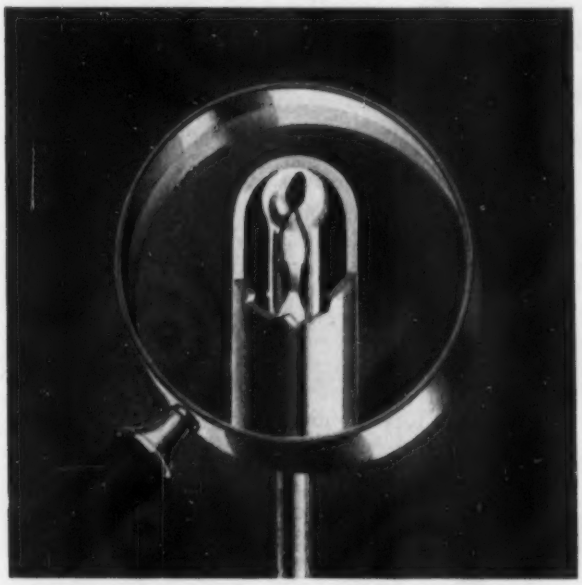
Communications Most Important—A major factor in the poor utilization of engineers is undoubtedly the lack of good communications between management and engineers. Management sometimes claim that engineers feel they are working in a research laboratory rather than for a company. On the other hand, engineers sometimes complain that the companies are exploiting them. Obviously there is simply a misunderstanding

Which of these two instruments provides the temperature control accuracy you need?



1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.

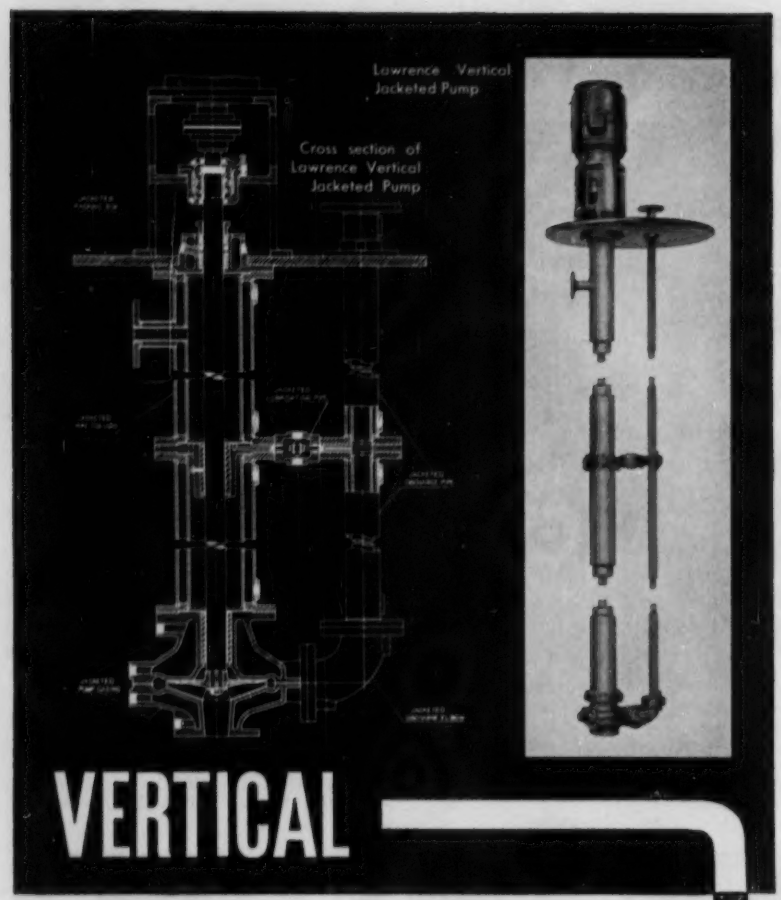
2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.



3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.

4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 1010 Pleasant St., Ashland, Mass.**

Fenwal Controls Temperature... *Precisely*



VERTICAL

jacketed PUMPS

Lawrence vertical jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc., which tend to solidify or become viscous at low temperatures. The heating medium can be steam, dowtherm, etc.

The pump is jacketed throughout, i.e. — the pump casing, pipe column, discharge pipe and packing box. All heating spaces are vented and self-draining.

For submerged operation, these pumps are frequently made with only the pipe column, discharge pipe and packing box jacketed; the pump itself, not being jacketed.

If you have to pump liquids which must be maintained above a certain temperature to prevent solidification, write us the pertinent details. No obligation.

Write for Bulletin 203-7.

LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

As Management Sees It . . .

that can be rectified by better communications. It is quite apparent that management should take the initiative since they have more to gain.

Communications serve the two-fold purpose of informing the individual about the company policies as well as his future with it. The engineer, realizing that his personal advancement is dependent upon the financial progress of the company, is essentially ambitious for it. Too often the engineer sits in a corner doing his work and gets only a worm's-eye-view of the project. In order better to perform his duties, he should be given an overall perspective of the project. When properly informed about his company, the engineer develops a deep sense of loyalty. Having a feeling that he belongs with an organization and that he is accomplishing something rather than just doing a job, the engineer thereby increases his efficiency.

Regular engineering conferences and seminars are used successfully in management-engineering communications. The most common method is the direct line of supervision. However, that is not enough. News letters have proven to be an effective method of keeping engineers informed. As a professional group, engineers are best appealed to on an individual basis. Thus, seminars and special forums are most effective because of the individual participation of the personnel.

Never in our history have engineers been in such great demand. With our expanding economy and defense efforts, we must make the most of what we have. Better utilization of engineers means more efficiency, less turnover, and an end to the so-called "engineer shortage."

LITERATURE CITED

How to Improve the Utilization of Engineering Manpower. Prepared by the National Society of Professional Engineers.

How to Improve Engineer-Management Communications. Prepared by the National Society of Professional Engineers.

How to Attract and Hold Engineering Talent. Prepared by the Professional Engineers Conference Board for Industry.

Chase, S., "Why Some Companies Have No Labor Trouble," *Reader's Digest*, June, 1952.

"Engineer Shortage, Treatment but No Cure," *Business Week*, May 23, 1953.

"How to Beat the Engineer Shortage," *Business Week*, Feb. 9, 1952.

Pinkerton, W. M., "Industry Clamors for Trained Men," *Popular Science*, January, 1953.

"Treating Engineers Like People," *Business Week*, August 16, 1952.

"To Fill the Gap, Catch 'em Young," *Business Week*, May 2, 1953.

Eaton, Kenneth J., "Management Engineers . . . Competitors or Collaborators," *Consulting Engineer*, March, 1955.

For more data on advertised products, use Readers' Service Cards, last page.

These are Zallea Pressure-Balanced Expansion Joints. They provide a sound engineering solution to the problem of absorbing pressure thrust where a change in direction occurs, and it is not possible to anchor the elbow.

Their operation is simple. Both expansion joints shown are designed to absorb axial and lateral movement in the inboard bellows. By means of tie rod action, the pressure thrust of the inboard bellows is balanced by the countermovement of the outboard bellows. This design is frequently used in piping connections to a turbine to eliminate the pressure thrust against the turbine casing. Many other applications may occur to the design engineer.

An original Zallea design, these specialized joints are another example of our ability to develop, engineer and manufacture expansion joints to meet your specific needs. For information on standard types, or help with special expansion or piping problems, call in a Zallea representative.

Zallea *expansion joints*

ZALLEA BROTHERS, 890 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

For more data on advertised products, use Readers' Service Cards, last page.

CALTEX Keeps Busy

Continued from Page 103

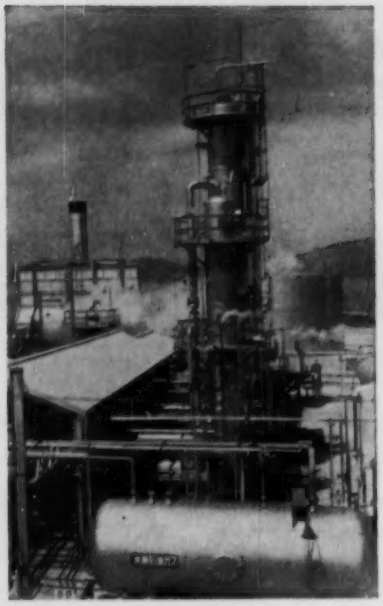
13,000 bpcd in 1950, has now climbed to 20,000. A new fluid catalytic-cracking unit, vacuum unit, and catalytic-polymerization unit are scheduled for 1957 completion.

Japanese war-damaged refineries were a different proposition. These, too, had been reduced to rubble by repeated bombings, but in the early postwar period it was the intention of U.S. occupation forces to scrap them completely as constituting a war potential. The plan at that time was to supply Japanese petroleum needs with imported products. But in 1948 it was decided that such a policy would create a dangerous drain on Japan's foreign exchange funds and the policy was changed, resulting in reconstruction of the damaged facilities by Japanese refining companies.

In 1949 Caltex acquired half interest in the Pacific Coast refineries of Nippon Oil Company, later transferred to a newly-formed jointly-owned company, Nippon Petroleum Refining Company, Ltd., to rebuild and modernize the Yokohama refinery in the Yokohama-Tokyo industrial area and the Kudamatsu refinery in the western portion of the main Japanese island of Honshu. About the same time Caltex bought a similar interest in Koa Oil Company, Ltd., and the Marifu refinery, also located in western Honshu.

Caltex financed additional construction to modernize and expand all three refineries. These programs, started in October, 1952, have now been completed with installation of platformers at Marifu and Kudamatsu and, at Yokohama, a crude unit, vacuum unit, a cat cracker, a propane deasphalter, additional lube oil manufacturing facilities and treating plants. In 1954 crude running at Yokohama was raised to 20,000 bpcd through modifications to the existing crude unit equipment.

The new facilities, designed jointly by Japanese and American technicians, incorporated the latest equipment and processes into all three refineries. Field construction was handled by Japanese labor, working for Japanese contractors. Today the refineries are manned and supervised



Platformer at the Caltex Kudamatsu refinery. In the background is the Inland Sea.

entirely by Japanese nationals. They manufacture a full line of petroleum products for about 23 percent of the Japanese market. Growth of these plants can be seen in the recapitulation of crude running (bpcd):

Year	Yokohama	Kudamatsu	Marifu
1951	6,100	5,700	5,400
1955 (estimated)	20,000	7,500	12,000

Presently, construction is under way on a 20,000-bpcd topping unit at Yokohama and a 15,000-bpcd crude unit at Kudamatsu, both to be completed in 1956. At Marifu, a 15,000-bpcd topping unit will be completed this year.

New Postwar Plants—In July, 1948, construction began on a Caltex refinery at Pernis, Holland, a suburb of Rotterdam. Holland offers many advantages: a tax treaty which gives American capital an open door, assurances that dividends can be taken out of the country and, on the whole, a friendly climate for U. S. investment. In addition, the Dutch demand for petroleum products has doubled since 1947. Also, Pernis is strategically located on deep water.

The refinery owned by Caltex Petroleum Maatschappij went on stream early in 1950, and supplies the Benelux countries, and Switzerland, West Germany and Denmark, with gasoline, kerosine, automotive and industrial diesel oils and fuel oils. About 90 percent of this production is shipped by water. The original design capacity of the plant was 20,000 bpcd. The present rated capacity is 35,000 bpcd. Crude running in 1950 was 20,713 bpcd; currently it averages over 39,000 bpcd. Facilities are included for thermal reforming and cracking and catalytic polymerization. Presently under construction for 1957 completion are a catalytic reformer and a diesel desulphurization unit.

On January 1, 1950, a quarter of the world apart, construction of two new refineries was started: one at Sidon, Lebanon, terminus of the Trans-Arabian Pipeline; the other on the shores of Batangas Bay in southwestern Luzon in the Philippines.

The Sidon refinery, owned by Mediterranean Refining Company, is vital to Lebanon because of that country's dependence on motor transport. The refinery that serves this economy, as well as that of Syria and Jordon, is a joint venture of Caltex and Socony-Vacuum Overseas Supply Company. The 6250 bpcd plant went on stream January 12, 1955, and an expansion program was immediately started. Included in the new equipment was a second Platformer. The refinery's operating equipment now includes a 9000-bpcd crude unit and two Platformers. This refinery is the largest industrial property in Lebanon.

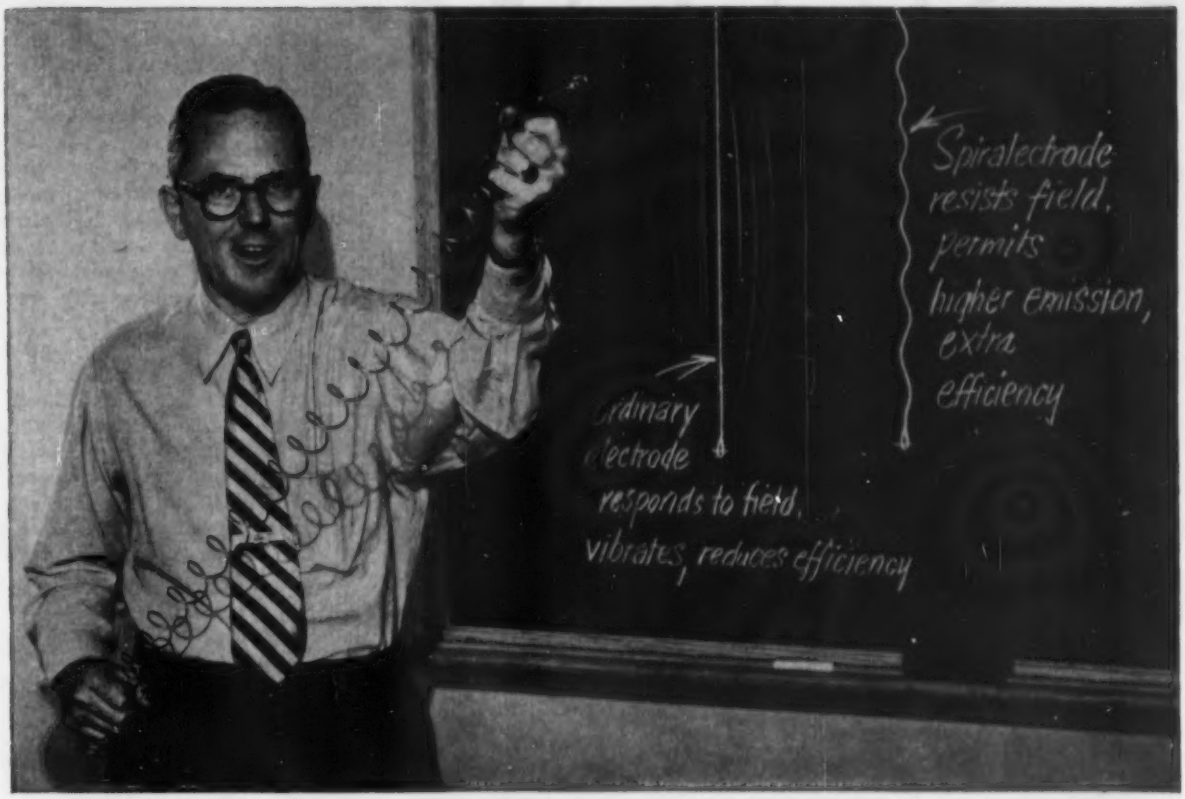
The installation of Caltex (Philippines), Inc., at Batangas, south of Manila, is the largest industrial plant in the Philippines and only refinery.

This new installation, which went on stream at the end of 1954, supplies about a third of an expanded Philippine market. The refinery's capacity is 13,000 bpcd. In addition to the crude unit, process equipment consists of a cat cracker, a propane decarbonization unit, and a catalytic polymerization plant.

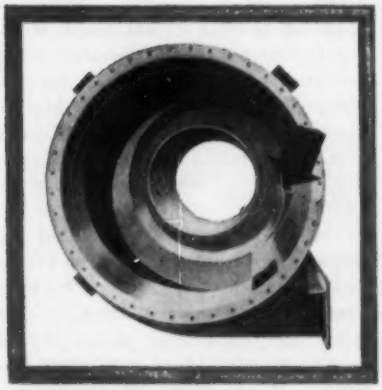
Caltex Affiliates—In Australia, Italy, and Spain, Caltex has joined with nationals in developing refineries.

The installation in Australia is at Matraville, near Sydney, in the heart of that nation's industrial region. It is operated by Bitumen and Oil Refineries (Australia), Ltd. (BORAL), in which Caltex has a 40 percent interest. Construction of the 6500-bpcd refinery was started in 1946 and completed in 1948. A second crude unit, with a capacity of 10,000 bpcd, is now under construction. Other equipment consists of a catalytic reformer, an asphalt plant producing 50,000

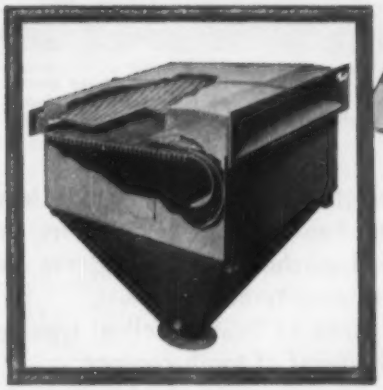
How Buell's Unique Spiralectrodes deliver EXTRA DUST COLLECTION EFFICIENCY!


Spiralectrode resists field, permits higher emission, extra efficiency
Ordinary electrode responds to field, vibrates, reduces efficiency

Coupled with the unique spiralectrode feature is Buell's Continuous Cycle Rapping—the most effective mechanism yet developed for dry dust precipitation. Completely eliminates puffing, keeps electrodes constantly clean. Re-entrained dust is minimized, peak efficiency is maintained.



Buell Cyclones also deliver extra efficiency, due to exclusive shave-off which harnesses double-eddy and puts it to work!



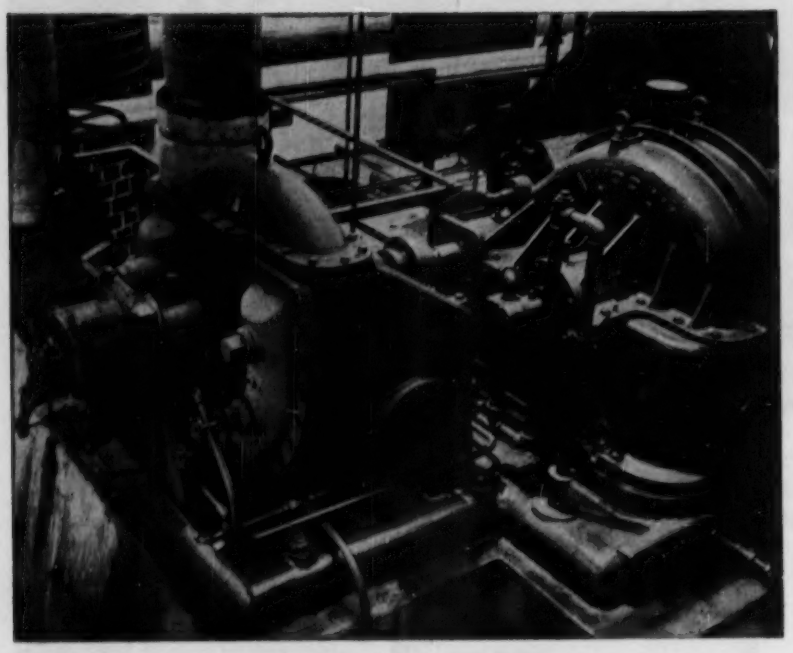
Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations.

For the complete story behind Buell's *extra efficiency*, write Dept. I-21, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

buell

MECHANICAL ELECTRICAL *Experts at delivering Extra Efficiency in* **DUST COLLECTION SYSTEMS**

Murray Turbines



One of 4 Murray type turbo-gear units installed in a southwest rubber plant still giving trouble free service after 12 years in an unprotected outdoor location. This unit drives an Induced Draft Fan requiring 425 HP at 683 RPM. The turbine speed is 3500 RPM.

• Murray turbo-gear units for mechanical drive are right at home in difficult outdoor installations. Fans, pumps, compressors, and many special types of slow speed machines are among the long list of installations powered by Murray turbo-gear units.
Murray gears are of the Herringbone or Double Helical type and all are pressure lubricated at the point of tooth contact.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

As Management Sees It . . .

tons a year, and a diesel desulphurization unit.

In Italy, the 13,000 bpcd San Martino refinery in the Po Valley is operated by Societa Per Azioni Raffineria Padana Olii Minerali (SARPOM), a joint Caltex and Fiat venture. Construction here was started in January, 1951, and completed in November, 1952. The plant is located inland in the center of a heavily industrialized area. It is fed by an 8-inch crude oil pipe line 97 miles long connecting the tanker terminal at Savona, 28 miles west of Genoa.

Besides serving the Italian market, Sarpom exports all principal petroleum products to West Germany, Greece, Switzerland, Austria, and France. In addition to the crude still, processing units at San Martino are a cat cracker, a catalytic polymerization plant, a vacuum unit and a thermal reformer.

Spain is the fourth country of Europe where Caltex is represented. Here the plant of Refineria de Petroleos de Escombreras, S.A. (Repesa) is at Escombreras, near the Mediterranean port of Cartagena. Caltex has a 24 percent interest in the operating company; the balance is controlled by Spanish interests. The refinery went on stream January 15, 1950, with an initial capacity of 5000 bpcd. Today, the capacity is 45,000 bpcd and Repesa supplies a substantial portion of the Spanish market. Its present equipment consists of two crude units, a thermal reformer, a catalytic polymerization plant, treating facilities and a 520-barrel-a-day lubricating oil plant. Its new lube oil plant was completed last March. Current construction calls for a crude unit, and catalytic reforming, to raise the refinery's over-all capacity to 60,000 bpcd.

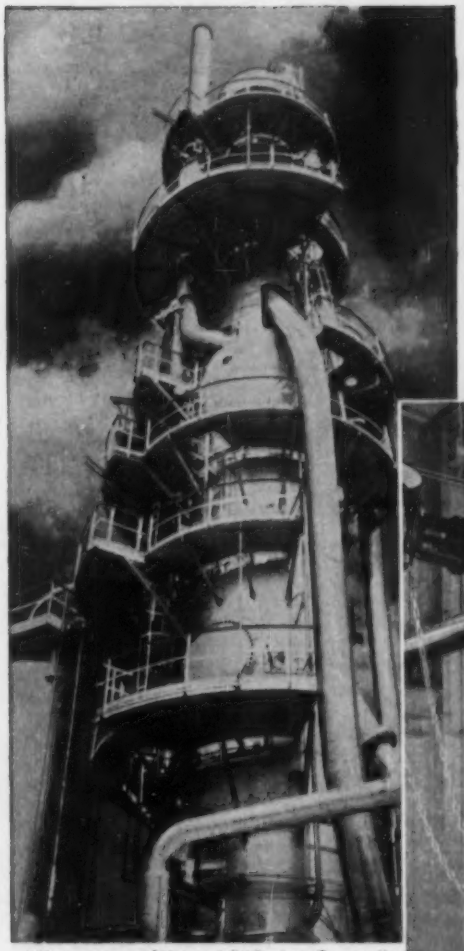
The operating refineries listed are helping to strengthen the Free World in the Eastern Hemisphere both in commerce and defense. They are carrying out the Caltex philosophy of investment abroad, of employing nationals at all levels, of purchasing materials in the countries where business is being done, thereby encouraging local industry and bolstering faith in U. S. free enterprise and its willing ability to contribute to the economic and cultural life of every nation. ##

I-R TURBO-BLOWER

supplies 13,800 cfm for

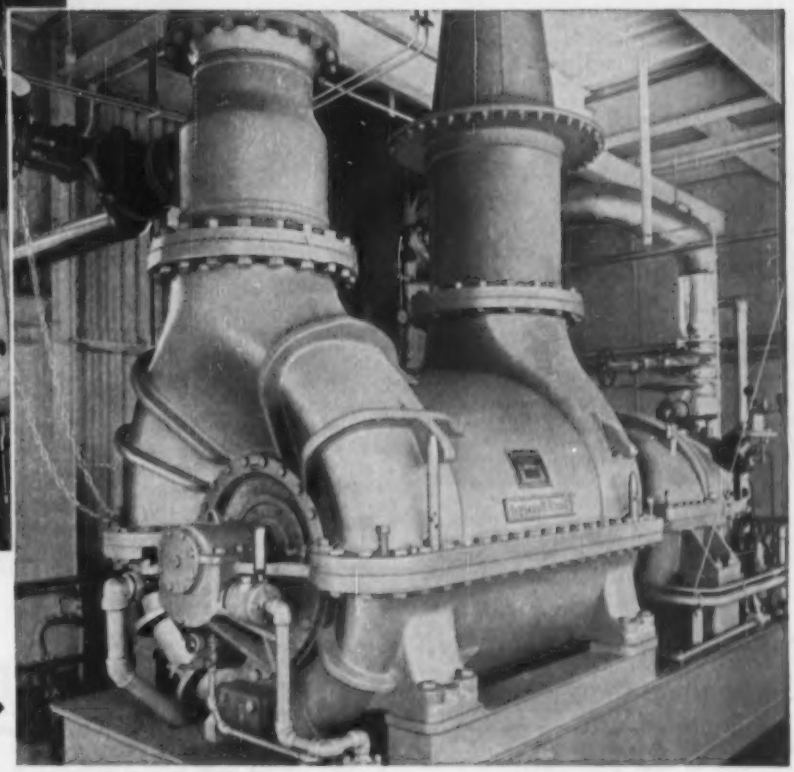
NEW CAT CRACKER

at Premier's Fort Worth Refinery



"Photo, courtesy of Universal Oil Products Company"

Premier's new 3,000 barrel UOP Fluid Catalytic Cracker.



Ingersoll-Rand steam turbine driven Turbo-Blower, rated 13,800 cfm, 46.3 psia discharge.

With the installation of this 3,000 barrel Catalytic Cracking unit, designed and licensed by Universal Oil Products Company, the Premier Oil Refining Company of Texas has completed a multi-million dollar expansion program at the Ft. Worth plant. The new unit permits operating the refinery at its crude oil capacity of 7,500 barrels a day — and provides not only the Fort Worth refinery but Premier's three other Texas refineries with a blending stock having an F-1 leaded octane rating of 98 to 100.

Air for the new Cat Cracker is supplied by the Ingersoll-Rand steam turbine driven Turbo-Blower shown above, which delivers 13,800 cfm at 46.3 psia discharge. Other I-R equipment serving Premier's Fort Worth Refinery includes three 165-hp JVG gas-engine-driven compressors, and a number of I-R centrifugal pumps.

Wherever dependability and economy of operation must go hand-in-hand, it pays to specify Ingersoll-Rand for your process equipment requirements. Call your I-R engineer for complete details.

12-231

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

What's Happening . . .

. . . in the Industry

Stauffer, Consolidated Lay Plans for Merger

The boards of Stauffer Chemical Company and Consolidated Chemical Industries, Inc., have agreed upon a plan of merger which would absorb Consolidated into the Stauffer Company. The plan, still to be acted on by stockholders in the two companies, would combine assets worth $120 million.

Directors of the two companies have recommended an exchange of 3¼ shares of Stauffer common stock for each participating share of Consolidated, excluding those already owned by Stauffer. The Consolidated operations would be carried on under the name, "Consolidated Chemical Industries Division of Stauffer Chemical Company."

Continental to Close Refinery at Glenrock

Continental Oil Company is suspending operation of its Glenrock, Wyo., plant as an oil refinery. The company has not decided what will be done with the 3500-barrel-a-day refinery. It may be sold, dismantled or converted to other operations.

A thermal crude distillation unit, the Glenrock refinery was built by Mutual Oil Company shortly after World War I, and then rebuilt by Conoco, which acquired it in 1924. The plant is located almost midway between Conoco's 10,000-barrel-a-day Denver plant and its 7750-barrel-a-day refinery at Billings, Mont.

Government Lifts Ban On Sending Data Abroad

Export license is no longer required to send technical data on petroleum-refining equipment to other countries. The Bureau of Foreign Commerce has abolished its list of petroleum data requiring licenses to be sent abroad.

Security controls are still in effect, however, on data directed to Communist and satellite nations. Exporters should consult bureau regulations before shipping information which might move indirectly into Communist hands.

The new regulations are in Export Bulletin No. 755, available from the Department of Commerce.

Chemical Future Bright

The Department of Commerce has predicted that the chemical and rubber industries will call 1955 their best year on record. The department's Business and Defense Services Administration expects chemical sales to reach close to $23.5 million, or 20 percent more than last year's record volume. For the rubber industry, the use of synthetic rubber will set a record, with output exceeding 900,000 tons.

For Industrial Peace

For outstanding contributions to industrial peace, The Fluor Corporation, Ltd., has been awarded the Father Coogan Labor-Management Award. The honor is given annually to an industrial firm and to affiliated labor groups which have achieved signal labor-management relations throughout the year. Along with Fluor, 29 international unions of the Los Angeles Building Trades Council, AFL, were honored. Presentation of the award to J. B. Fluor (right), vice president of the company, and Ralph A. McMullen (left), president of the Building Trades Council, was made by James Francis Cardinal McIntyre.

Whiting Refinery Due To Increase Capacity

Standard Oil Company (Indiana), back in operation at Whiting, Ind., within a month after its refinery there was devastated by fire, expects to bring additional crude-running equipment on stream later this month, raising the plant's thruput to some 150,000 barrels a day.

The refinery now is running 100,000 barrels of crude a day, or nearly 50 percent of its normal capacity. The company's five other refineries are operating at full capacity while operations are restricted at Whiting.

Despite the fire, however, the company is continuing with plans to shut down its Mandan, N. D., refinery for a routine turnaround. The plant is expected to be out of operation about two weeks in October.

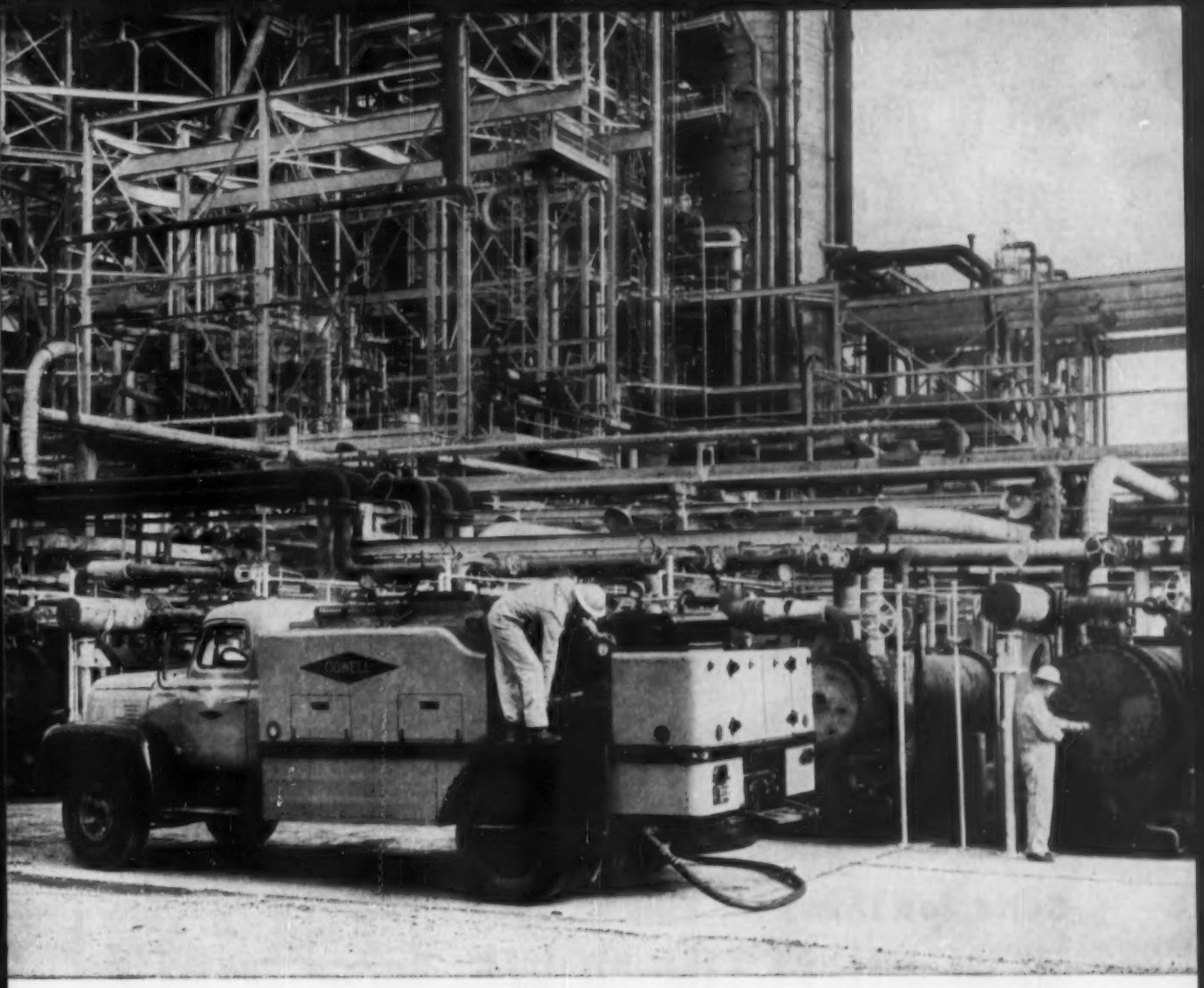
The Whiting refinery, already hit by one fire believed to have cost $10 million, was struck again last month by a fire and explosion in the filter plant. Estimates on damages from the second blast ran $50,000 and upward.

A claims office set up at the hard-hit refinery is processing claims for damages outside the refinery proper. The claims office was in operation within two days after the fire started.

Southern California Plans Industrial Research Center

The University of Southern California, marking the golden anniversary of its first engineering course, plans to establish on the campus a $1-million Southern California Industrial Research Center.

The new center will receive financial support from a number of participating private corporations. Two new members,



While the cat cracker remained in full operation, DOWELL cleaned six slurry exchangers chemically . . .

UPPING THROUGHPUT 900 BPD

No cat cracker operator wants to see his throughput go down. Neither did this one. Nor could he afford to wait for the annual shutdown to give six slurry exchangers the cleaning they obviously needed *fast*. His solution? Call Dowell to remove the scale deposits with chemicals.

Dowell engineers devised a procedure for cleaning the exchangers *with the cat cracker in full production*. The exchangers were cleaned by Dowell one at a time, while the remaining five units carried the load.

As a result of chemical cleaning, the operator reported a jump in throughput of *900 barrels per day* . . . plus an average increase of 26° in the heat co-efficient of the exchangers.

Dowell Service is designed to restore *your* equipment to top efficiency—and do it *fast*, with the very minimum of costly downtime. Experienced Dowell engineers do the job for you. They bring all the necessary chemicals, pumps and control equipment right into your plant. Solvents are introduced through regular connections, holding dismantling to a minimum.

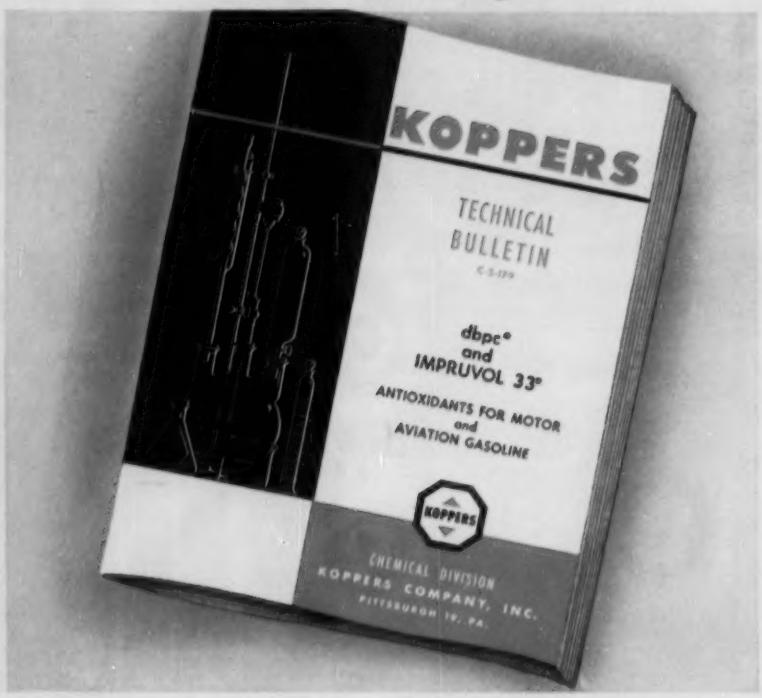
For full information on a program of Dowell chemical cleaning for *your* plant, call your nearest Dowell office. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. J-31.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Want to improve gasoline quality and reduce treating costs?



Send for this

NEW BULLETIN NOW!

This new technical bulletin on **dbpc*** antioxidant (2,6 di-tertiary-butyl-para-cresol) was developed to help the refiner understand more fully the many factors which influence gasoline gum formation and automotive induction system deposits. Much of the data is dramatically revealed through newly designed laboratory equipment which is described in detail. And a new inhibiting practice is outlined for the refiner who wishes to improve gasoline quality while reducing treating costs.

Interesting charts, tables, and effectiveness graphs on **dbpc** antioxidant in use and in storage are contained in the bulletin. Furthermore, actual comparisons are made with different types of inhibitors to prove the efficiency and economy of **dbpc** antioxidant.

• • •

Send for your free copy of this factual, informative bulletin, today. Find out how you can make a better gasoline at less cost. Write to:

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-105, Pittsburgh 19, Pennsylvania

KOPPERS **Koppers Chemicals**

SALES OFFICES: NEW YORK • BOSTON • PHILADELPHIA • ATLANTA
CHICAGO • DETROIT • HOUSTON • LOS ANGELES

What's Happening. . .

at $50,000 for a three-year period, are The Fluor Corporation, Ltd., and Union Oil Company of California.

Member companies will be given access to the activities of the research center, and their interests will be represented in exploring unusual problems. The center will be made up of four buildings which will comprise an extension to the present School of Engineering.

Octane Averages Hit New Record Highs

Gasoline on sale at service stations in September rose to a nationwide weighted average of 96 octane number for premium and of 88.8 octane number for regular, according to a monthly survey of 53 cities by Ethyl Corporation.

Premium gasoline was 0.1 octane number higher than its corresponding August average and regular gasoline was 0.3 octane number higher. On a year-to-year basis, premium gasoline was 2 octane numbers higher and regular gasoline was 1.8 octane numbers higher than in September 1954.

Average tetraethyl lead contents in September were 2.62 ml a gallon of premium gasoline and 2.30 ml a gallon of regular gasoline.

Of the cities covered in Ethyl's survey, 32 reported increases over August in the average octane number of their premium gasolines, with nine of these gaining 0.5 octane number or more. In regular gasoline, 43 cities had a higher average antiknock quality than in August, with 16 showing a gain of 0.5 octane number or more.

Compared with the nationwide premium average of 96 octane number, 16 cities reported premium averages of 96.5 octane number or higher. In regular gasoline, 15 cities showed average octane ratings of 89.5 octane number or higher, compared with the national weighted average of 88.8 octane number.

Medical Group Okays Twenty-Two Plants

In a report of approved medical services in the refining industry, the Occupational Health Institute has listed 22 refineries and related plants as meriting its Certificate of Health Maintenance. The recognition is given to plants complying with standards set up by the institute for medical service in industry.

Companies which had plants receiving certificates were The Carter Oil Company, Esso Research and Engineering Company, Esso Standard Oil Company, Ethyl Corporation, General Petroleum Corporation, Humble Oil & Refining Company, Imperial Oil, Ltd., Lago Oil & Transport Company, Phillips Petroleum Company, Socony Mobil Oil Company, Standard Oil Company (Indiana), and Standard Vacuum Oil Company.

Cortines Praises Pemex

President Adolpho Ruiz Cortines, in a report to the National Congress, spoke of the "brilliant future" of Mexico's oil industry. Praising the accomplishments of Petroles Mexicanos for the past year, he

. . . he can save dollars on WATER costs!

C.P.G.—means cost per gallon and water costs are an all important item to city — farm or industry.

The man from Layne knows most about water costs and how to cut them—for the man from Layne knows most about every phase of water development.

Exploration . . . modernization . . . equipment . . . well drilling all affect C.P.G. — and when you "ask the man from Layne" you get authoritative, factual information on any question that relates to water.

Layne Associate Companies throughout the World

LAYNE & BOWLER, INC.
General Offices
MEMPHIS 8, TENNESSEE

water wells • vertical turbine pumps • water treatment

LIKE TO RACK UP A ROLLING TIME RECORD?
It's a safe bet you WILL...with an AIRETOOL Tube Expansion Control System
IT'S AUTOMATIC!

Nothing beats betting on a *sure* thing! And that you do when you rely on the Airetool tube expansion control system. Automatic, the Airetool system with its preset control quickly rolls joints to a uniform tightness. Gives maximum bonding between tube and sheet. Over-rolling is, therefore, eliminated . . . and rolling time is notably shortened, from hours to minutes.

Motors are available in four sizes to supply proper power for your purpose. Entire system is portable.

Call for an ON-YOUR-JOB DEMONSTRATION Today!

BRANCH OFFICES:
New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

REPRESENTATIVES
In principal cities of U.S.A., Canada, Mexico, England, South America, Puerto Rico, Japan, Italy, Hawaii.
European Plant: Airetool Nederland N.V., Vlaardingen, The Nederlands.

"There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction."

What's Happening. . .

said the government monopoly has played a major role in the country's recovery.

Pemex, Mexico's biggest taxpayer, has hit an average 220,754-barrel-a-day refining output. Mexicans used 51,741,000 barrels of gasoline and other products last year, and a total of 21,398,000 barrels of products were sold abroad.

New History Covers Jersey Standard Company

The first of four volumes covering the history of Standard O1 Company (New Jersey) is due to be published for Business History Foundation. Put out by Harper & Brothers, the first volume takes up the first 29 years of the company's history—through the 1911 dismemberment decree.

The book, an 800-page volume, was written by Ralph W. Hidy, professor of history at New York University, and Muriel E. Hidy, an associate of the foundation. It is entitled, "Pioneering in Big Business."

The authors, who spent eight years in writing the book, were given free access to company records, and Jersey agreed that the foundation would have complete freedom in its finding and interpretation of research in writing the history.

The company also made an original grant equal to the estimated cost of the project, plus a sum to cover contingencies. One payment was made to avoid any implication that the foundation could be subject to financial pressure while preparing the history.

Lion Oil to Operate As Division of Monsanto

Lion Oil Company has been merged into Monsanto Chemical Company. Stockholders, at separate meetings, approved a plan to merge the two companies into a $550-million concern. Lion Oil will operate as a division of Monsanto under its own name.

Dow Corning Wins Achievement Award

Dow Corning Corporation has been named winner of the 1955 Award for Chemical Engineering Achievement. The company was selected by an 84-man committee headed by Walter G. Whitman, director of the Chemical Engineering department at Massachusetts Institute of Technology.

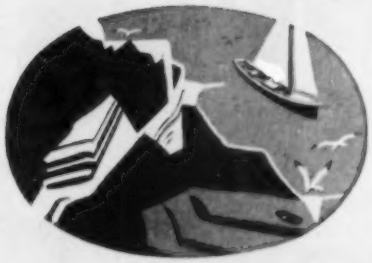
Since 1933 a dozen companies or industrial groups have received the biennial award for their successes in the development, design and operation of plants and processes. But in selecting Dow Corning as winner of the 1955 award, the committee for the first time honored a company primarily for the participation of its chemical engineers in the commercial development of new products, markets and sales.

Awards 14 Scholarships

The Atlantic Refining Company has awarded 14 undergraduate and two graduate scholarships at colleges and universities in the South, Southwest and Midwest for the current academic year. The purpose

HARSHAW
Tableted
CATALYSTS

FROM **strong** TO *soft*



as rock! *as chalk!*

whatever you specify

Typical Harshaw Catalysts:

- Aluminum Chloride Anhydrous
- Boron Trifluoride
- Boron Fluoride Addition Compounds
- Hydrofluoric Acid Anhydrous
- Alumina—active or inert
- Chrome Alumina
- Molybdena Alumina
- Tungsten Alumina
- Cobalt Molybdena Alumina
- Copper-Chromium Oxide
- Magnesia
- Nickel
- Vanadium
- Zinc-Chrome

Harshaw Catalysts available in these forms:

Tablets · Powders · Spheres · Flakes
Extrusions · Granules · Rings

Use Harshaw Catalysts for these processes:

- Hydroforming
- Cyclization
- Oxidation
- Dehydrogenation
- Hydrogenation
- Dehydration
- Desulphurization
- Alkylation
- Isomerization

Harshaw Catalysts—made exactly to your specifications of raw materials, chemical composition, and physical properties such as length, diameter, crushing strength, abrasion resistance, bulk density, etc. AND delivered when you want them!

Harshaw has the know-how—we pioneered in making customer specified catalysts. Harshaw has the facilities—we produce carloads every week!

We are to you like the druggist is to the doctor . . . write your catalyst prescription and depend on Harshaw to fill it.

Our free booklet "Harshaw Catalysts" is yours for the asking. Write today.

The HARSHAW CHEMICAL Co.

CLEVELAND 6, OHIO

CHICAGO · CINCINNATI · CLEVELAND · DENVER · HOUSTON · LOS ANGELES
NEW YORK · PHILADELPHIA · PITTSBURGH

A Good Turn For Motorists

Most people consider a car the second-biggest purchase they'll ever make. Anything that extends its life or improves performance naturally contributes to your pocketbook as well as your motoring pleasure. Since our new "Detergent-Action" Gasolines do both, they're prime examples of Standard's planning for you.

Standard has built 4 catalytic reformers in the West to make these cleaner-burning, more powerful motor fuels required for best performance of today's higher compression engines. This program was two years in planning and building—cost $50 million.

This $50 million worth of plants is only part of the $350 million Standard is investing this year to make petroleum more useful and plentiful. Some of it will go for product research, part will pay for new manufacturing facilities. A good share will finance the search for new sources of oil to help supply the 733 gallons a year per person that go into thousands of oil-born products essential to modern living.

So the $350 million is an investment in your future as well as ours. It's one way Standard helps guarantee there'll be plenty of oil to do more jobs today and in the years to come.

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better

For more data on advertised products, use Readers' Service Cards, last page.

of the program, started in 1953, is to assist students who show promise of success in the fields of science, engineering and research directly related to the petroleum industry.

Esso Research Establishes New Prize in Chemistry

An annual award of $1000 and a medal has been established for outstanding achievement in industrial and engineering chemistry. The prize, to be given by Esso Research and Engineering Company, will be known as "The American Chemical Society Award in Industrial and Engineering Chemistry."

The purpose of the prize is to stimulate fundamental research in industrial and engineering chemistry and in the development and application of chemical engineering principles to industrial processes. The first award will be made in 1956.

El Segundo Equipment Controls Air Pollution

The air-pollution control system for processing equipment at the largest refinery in Los Angeles County is 99.9 percent effective in keeping invisible smog-forming gases out of the air, according to D. K. Harger, who runs the Standard Oil Company of California refinery at El Segundo.

The plant's general manager said that in handling 40,000 tons of gasoline a day, the refinery does even better, cutting evaporation losses to a mere .05 percent. He cited a newly-perfected design for controlling gasoline vapors lost during loading operations, pointing out that the installation would cost $240,000 and further reduce the refinery's vapor loss by 1200 pounds a day.

At least ten times as much gasoline is lost to the atmosphere by operators of automobiles as is lost from all the refineries in the U. S., he said.

Can-Amera Oil Sands Buys Alberta Pilot Plant

Can-Amera Oil Sands Development, Ltd., has exercised its option to purchase the Alberta government's oil-sands pilot plant at Bitumont. The company recently entered an agreement with Royalite Oil Company, Ltd., to develop oil sands.

Additional facilities will be built to step up the extraction of oil from the bituminous sands of northeast Alberta. The sands are believed to contain as much as 300 billion barrels of oil, which the company hopes to sell at prices competitive with crude.

Estimates on equipment required for full production have run as high as $50 million. Facilities would include coking and sulphur-recovery plants, plus a pipe line and separating plant.

To Buy California Plant

Malco Asphalt & Refining Company has completed arrangements for the purchase of Wilshire Oil Company, operator of a 22,000-barrel-a-day refinery at Norwalk,

Safe and Sure Packing for
HOT OIL CHARGE PUMPS
...ends packing blowouts and hot oil flashes

JOHN CRANE

High Temperature
METALLIC PACKING

STYLE 101-AL (Aluminum)

Available in spirals and die-formed rings to specific stuffing box sizes.

Made of continuous thin ribbons of soft aluminum foil, spirally wrapped, crinkled and folded about a small core of pure dry asbestos roving, and squared to desired size.

ADVANTAGES . . . Minimum wear on shaft sleeves . . . Easy adjustment by gland takeup . . . Operation at highest temperatures . . . Easy cutting of rings from stock spirals.

SERVICE . . . High Temperature centrifugal hot oil charge pumps . . . hot oil valves . . . Diphenyl valves . . . still necks.

"John Crane" High Temperature Metallic Packings have been developed, as a result of years of extensive research, to withstand temperatures as high as 750°F.—discharge pressures of over 800 lbs.—speeds of 3600 rpm or more.

These "John Crane" Packings have been in continuous use on heavy and light hot oil charge pumps for years without maintenance or attention. One user reports . . . "seven years of continuous service and still as dependable as the day it was installed."

For a truly dependable packing for hot oil charge pumps, specify "John Crane" Style 101-AL. For the right combination of "John Crane" Packings to meet your specific needs, consult with experienced Crane Packing Company field engineers.

Send for catalog giving detailed information on "John Crane" complete line of packings for all services. Crane Packing Co., 1800 Cuyler Ave., Chicago 13, Illinois. *In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.*

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

For more data on advertised products, use Readers' Service Cards, last page.

THIS battery of "Automatic" Sprinkler SUPROTEX-DELUGE valves is assurance of intensive fire-fighting power for this fluid catalytic cracking unit.

Heat-sensitive Rate-of-Temperature-Rise detectors, located throughout the superstructure of the plant, feel fire at inception. Then, in but a matter of seconds, scientifically engineered "Automatic" FIRE-FOG systems take over. Alarms sound, location of the blaze is determined, and fire control or extinguishment is an instantaneous accomplishment.

FIRE-FOG is but one of many advanced types of ENGINEERED Special Hazard PROTECTION developed by "Automatic" Sprinkler Corporation of America. Research into the cause of disastrous fires, endless testing, and much practical field experience has enabled us to design, manufacture, engineer and install the specific type of protection needed to combat every fire hazard. Fixed piping systems of "Automatic" Sprinklers, water spray, high and low pressure CO_2, Air Foam, Dry Powder and Chemical Foam stand guard over leading petroleum and chemical processing properties throughout the Western Hemisphere.

Our highly trained staff of Special Hazard engineers will gladly assist you in the development of a fire-safe, investment-saving future for your business. Write or call us for service today.

"Automatic" Sprinkler
CORPORATION OF AMERICA
YOUNGSTOWN, OHIO

Offices in Principal Cities of North and South America

What's Happening. . .

Calif. Details of the merger were not available. Malco, the former New Mexico Oil & Refining Company, operates a 7500-barrel-a-day plant at Artesia, N. M.

API Refining Division Sets Canadian Meeting

American Petroleum Institute's Refining division will hold its 1956 mid-year meeting at Montreal. According to E. B. McConnell, API vice president for refining, the Canadian city was selected "to signal recognition to the dominion's growing oil industry."

The meeting, to be held May 14-17, will mark the first time the group has met outside the U. S. Program for the meeting is being drawn up by a committee headed by G. L. Mateer, president of Cities Service Petroleum, Inc., of New York.

Eleven technical sessions have been scheduled tentatively for the Montreal meeting, including two sessions on analytical research being developed by a committee under C. E. Headington, with The Atlantic Refining Company in Philadelphia. The Committee on Training, headed by Dean S. Turner, of The Standard Oil Company (Ohio) in Cleveland, is preparing a training session.

There will be sessions on air pollution and waste-water disposal developed by the Smoke and Fumes committee of the Committee on Disposal of Refinery Wastes. W. H. Claussen, executive secretary, with California Research Corporation in San Francisco, is collaborating with John H. Eashagen, chairman of the Refinery Wastes committee.

Corrosion, electrical equipment and instrumentation will be the topics of three sessions of particular interest to mechanical engineers in the refining industry. In addition, there will be a session on processes, one on fuels and lubricants and one on refinery maintenance.

Offers of papers should be addressed to W. T. Gunn, Room 2040, 50 West 50th Street, New York 20. The title and a brief description of the contents of the paper should be included with each offer.

Socony Mobil Makes Basic-Research Grant

Socony Mobil Laboratories has made a grant to Rensselaer Polytechnic Institute for an investigation aimed at solving problems involved in the friction and lubrication of solids. The grant, amounting to $5000, will be used with a contribution from Grumman Aircraft Engineering Corporation to aid in supporting a research program coordinated by the school's Research division.

New Machine to Solve Mathematical Problems

A new machine that can solve complex accounting and engineering problems or analyze data in a flash is being installed by the Accounting division at the Standard Oil Company (Indiana) refining in Whiting, Ind.

Called a "magnetic drum processing machine," the new device can add or subtract 340 numbers five digits long; make

For more data on advertised products, use Readers' Service Cards, last page.

Specify "TUBE-TURN" and you know you're right

THIS TUBE-TURN* Welding Return has a bursting strength at least equal to that calculated for the seamless pipe with which it is recommended for use. Made in U.S.A., it meets all American Standard and Safety Code requirements. Welders everywhere know it will line up perfectly . . . because it's forged by the only process that produces a wall with the maximum uniformity of thickness and circularity. In short, when you specify "TUBE-TURN" you *know* you're right.

Your nearby Tube Turns' Distributor is at your service. He can simplify your planning, meet your requirements exactly, with industry's most complete line of welding fittings and flanges.

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet *all* U.S. piping code specifications.

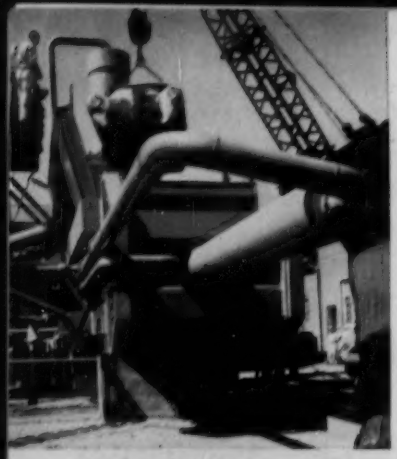
TUBE TURNS LOUISVILLE 1, KENTUCKY

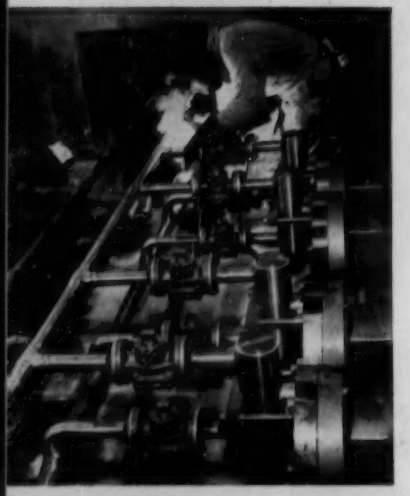
A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

PIPING HELP





How TUBE TURNS' SERVICE can help simplify your piping jobs

1 ENGINEERING SERVICE

This unique press squeezes old automobiles into bales of metal to expedite scrap recovery. Designers of the press called on Tube Turns' Engineering Service for assistance in laying out the piping for the hydraulic system. Result—efficient, leakproof piping that enables the press to do its job on a two-minute cycle. Tube Turns' unmatched piping experience can help *you* when you have an out-of-the ordinary piping problem.

2 COMPLETE SELECTION

Here is a stainless steel nitric acid header using TUBE-TURN* Welding Fittings and Flanges for directional changes and valve connections. Stainless steel piping can provide long, safe service where corrosive gases or fluids are handled, or where temperature extremes are encountered. You can select TUBE-TURN Welding Fittings and Flanges in carbon steel, stainless steel, non ferrous metals and alloys, and in the schedules and sizes you need. Tube Turns offers industry's broadest line of welding fittings and flanges, covering over 4000 items.

3 FAST SERVICE

You expect a manufacturer to exercise strict quality control over his production—what about distribution of his products? Here again Tube Turns offers you outstanding service. Tube Turns selects *leading* distributors who maintain local stocks, are geared for fast service, and rate "A" for dependability. You can save purchasing time and inventory trouble when you work closely with your Tube Turns' Distributor. You'll find one in every principal city.

MATERIALS DATA . . . Tube Turns is recognized as a leading source of authoritative information on piping design. For booklet on "Pipe and Fittings Material", fill out and send the coupon now.

TUBE TURNS, Dept. Y-5
224 East Broadway, Louisville 1, Kentucky
Please send bulletin on "Pipe and Fittings Material".

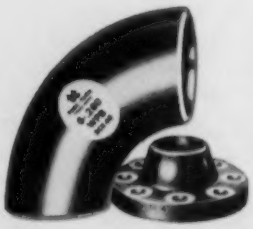
Company Name _____

Company Address _____

City _____ *Zone* _____ *State* _____

Your Name _____

Position _____



DISTRICT OFFICES:

New York	San Francisco
Philadelphia	Seattle
Pittsburgh	Atlanta
Cleveland	Tulsa
Detroit	Houston
Chicago	Kansas City
Denver	Dallas
Los Angeles	Midland, Texas

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

112 multiplications or divisions of five-digit numbers, or make 400 comparisons. Only one second is required for the machine to make any of these computations.

The machine "remembers" on a magnetic drum. The drum stores information by means of magnetic spots on its surface. It can store 2000 numbers ten digits long. Information to be processed is fed into the machine on punched cards, and it answers by punching other cards.

Gulf to Investigate Nuclear Radiation

Gulf Oil Corporation, joining the move to apply nuclear radiation to petroleum refining, will install a 3-million-volt particle accelerator at its research center in Harmarville, Pa. The unit, a Van de Graaff accelerator, will produce streams of electrons, protons, neutrons and penetrating X-rays.

Company scientists will use the new device to study the effects of radiation on a wide range of petroleum and petrochemical processes, as well as for improving analytical techniques and developing new catalytic agents. The company also plans to explore the possibilities of applying nuclear energy to the manufacture of petroleum and petrochemical products.

Dr. Blaine B. Wescott, vice president in charge of research, expressed hope that radiation can be used to improve the performance characteristics of petroleum products. He believes that irradiated products can be manufactured which will be superior to present-day high-quality products.

"We need to find out if, through nuclear energy, important improvements can be made in conventional refining and petrochemical processes," he said. "If this should prove feasible it could lead to the development of totally new and different products, as well as to more efficient refining operations whereby we can achieve absolute maximum usage from a barrel of crude."

Wisconsin Refinery Sold

Wisconsin Oil & Refining Company's 5000-barrel-a-day refinery at Sheboygan, Wis., has been purchased by Gustafson Oil Company, a Milwaukee, Wis., marketing firm. The plant had been recently closed down.

Awards Fellowships

Ten graduates of California universities and colleges have been awarded Richfield Oil Corporation fellowships to further their educations at an advanced level during the 1955-56 academic year.

ERRATUM

In Irving Granet's article, "Heat Exchanger Expansion Calculations," August Petroleum REFINER, pages 101-104, Figures 2 and 3 were inadvertently transposed. The figure that appeared on page 103 should have been labeled "Figure 2—Temperature distribution in counterflow operation." The figure on page 102 is actually "Figure 3—Temperature distribution in parallel flow operation."

EC&M 2200-5000 VOLT

MOTOR STARTERS

Pay off!

with ① CERTIFIED 50,000 KVA interrupting capacity
② Oil-immersion for corrosion protection
③ Dependable, low-cost operation

In tank farm, gathering station, and pipeline pumping station applications, EC&M high voltage motor starters have earned a reputation for dependable, low-cost operation.

EC&M starters are virtually trouble-free, oil-immersion keeps working parts well lubricated . . . protects against corrosion. And, being automatic push button type, these starters make it easy for a station attendant to start or stop the motor-driven pumps as required.

In prominent oil centers, EC&M 2200-5000 volt motor starters are recognized for their efficiency and long life.

Investigate them today!

Write for Booklet 1062

THE ELECTRIC CONTROLLER & MFG. CO.

4498 Lee Road, Cleveland 28, Ohio

6079

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

Charles Leet, general manager of Esso Standard Oil Company's East Coast Manufacturing division, has been elected a director of Creole Petroleum Corporation. He will join Creole in Venezuela.

Leet joined the Standard Oil Company (New Jersey) organization in 1930 as a student engineer. He later transferred to Esso's Baton Rouge, La., refinery as a chemical engineer and subsequently became head of the Process Engineering department.

After serving as head of Esso's Technical Service division, he was named assistant manager of the Baton Rouge plant in 1951. Two years later he was appointed manager of the Esso refinery at Bayonne, N. J., and late in 1953 he moved up to general manager of the East Coast division.

Frederick D. Rossini, head of the Department of Chemistry and director of the Petroleum Research Laboratory at Carnegie Institute of Technology, has been appointed chairman of the National Research Council's Division of Chemistry and Chemical Technology for a two-year term.

The appointment was made by the president of the National Academy of Science which acts as official scientific advisor to the government. The National Research Council is an instrument of the academy used to bring scientists and engineers together to further research in the interest of the U. S.

Jack F. McKenna has joined the staff of API's Department of Technical Services, and been assigned to its Safety and Fire Prevention Services. He was an active member of several API Safety and Fire Prevention committees in his former capacities as safety director with Lion Oil Company and Aurora Gasoline Company successively.

McKenna started with Lion Oil in 1933 as a refinery maintenance man at El Dorado, Ark., where he held progressively higher assignments until 1943 when he was named safety engineer for the Refining division. Five years later he was promoted to assistant safety director for the company, and in 1951 moved up to safety director.

His administration saw Lion Oil receive the National Safety Council's Award of Honor in 1952 and 1953. McKenna joined API's permanent staff after serving Aurora Gasoline Company in Denver, where he had been safety director since 1954.

Fred Hederhorst, with Humble Oil & Refining Company at Baytown, Texas, has been promoted to research specialist in the refinery's Research and Development division. In his new position, Hederhorst will coordinate mechanical projects and take an increasingly active part in designing, constructing and starting up research and pilot-unit equipment. He joined Humble in 1930.

Tuemmler

O'Neal

Two Shell Men Honored By Chemical Societies

Fred D. Tuemmler, with Shell Development Company at Emeryville, Calif., was given international recognition when he was elected secretary of the Analytical section of the International Union of Pure and Applied Chemistry at the section's recent conference in Zurich, Switzerland. He will serve during the 1955-1959 term.

The Union, founded in 1918, is concerned with establishing and promoting cooperation between chemical societies of the world. It has been active in standardizing organic and inorganic nomenclature, in issuing the standard table of atomic weights and other fundamental constants, and in establishing uniform conventions for designing liquid cell potential.

Dr. Tuemmler joined Shell Development Company in 1937, after completing his Ph.D. in chemistry at Harvard University. He also holds a master's degree in chemistry from Harvard and a B.S. from Shurtleff College in Alton, Ill.

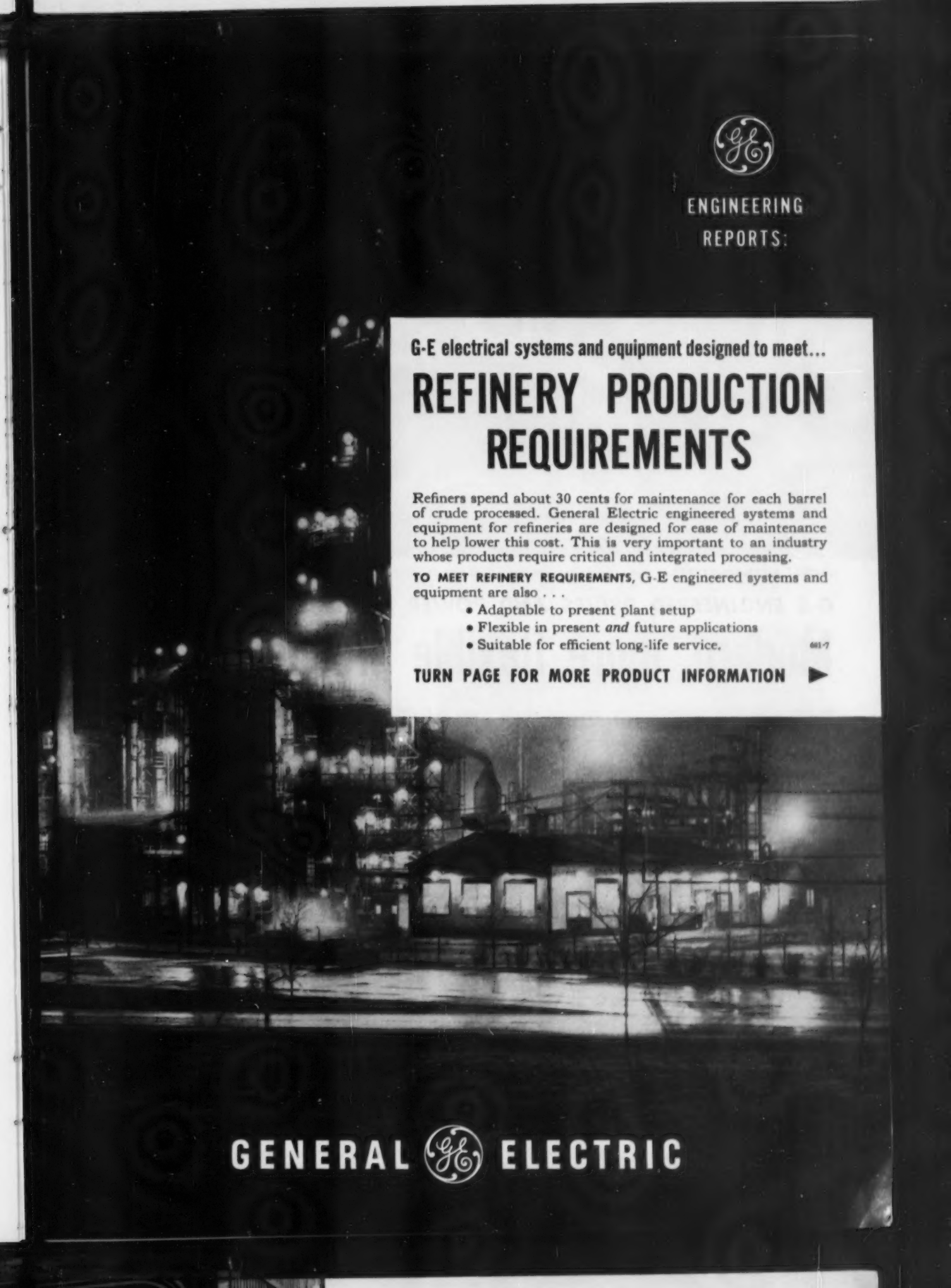
He is a member of ASTM, the California section of ACS, a fellow of London's Institute of Petroleum and an honorary member of its Standardization committee. He received the Award of Merit from ASTM in 1953.

M. J. O'Neal, with Shell Oil Company in the research laboratory at its Houston refinery, has been named to receive the Precision Scientific Company Award in Petroleum Chemistry for 1956. The award was announced at the ACS national meeting in Minneapolis.

Consisting of $1000 and a certificate, the award was established in 1948 to recognize, encourage and stimulate chemistry in the U. S. and Canada. It is based on outstanding research in the chemistry of petroleum or in fundamental research that contributes to the knowledge of petroleum and its products.

The 1956 award went to O'Neal on the basis of his developing high-temperature mass spectrometry and applying it to the knowledge of the composition of petroleum. Although mass spectrometers have been used for years in the analysis of gases and gasolines, it was O'Neal who solved the problem of applying mass spectrometry to the analysis of such heavy products as lube oil and waxes.

At Shell's Houston refinery since 1944, O'Neal is in charge of the laboratory's Analytical Research group. In 1950 he was elected chairman of the Gulf Coast Spectroscopic Group, and has served as


ENGINEERING
REPORTS:
G-E electrical systems and equipment designed to meet...
REFINERY PRODUCTION REQUIREMENTS
Refiners spend about 30 cents for maintenance for each barrel of crude processed. General Electric engineered systems and equipment for refineries are designed for ease of maintenance to help lower this cost. This is very important to an industry whose products require critical and integrated processing.
TO MEET REFINERY REQUIREMENTS, G-E engineered systems and equipment are also . . .
• Adaptable to present plant setup
• Flexible in present and future applications
• Suitable for efficient long-life service.
661-7
TURN PAGE FOR MORE PRODUCT INFORMATION
GENERAL ELECTRIC

SEVERAL AVAILABLE TYPES of protective enclosures make G-E motors ideal for all indoor or outdoor uses. New Polyex insulation

G-E ENGINEERED DRIVES AND POWER SYSTEMS MEAN . . .

Modern, more flexible processing lines

IN THE NEXT TEN YEARS, production must increase an estimated 50% to meet greater consumer needs. Available manpower will increase only an estimated 14% during the same period.

INCREASED OUTPUT AND EFFICIENCY must close the production gap between available manpower and estimated demand. General Electric electrical systems are designed and installed for efficient, flexible, easily expanded production.

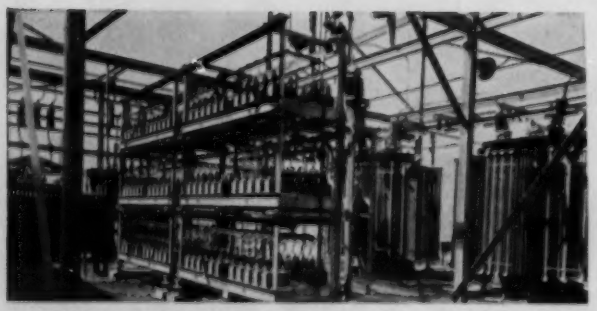
G-E ENGINEERING SERVICES (see back page) can help you meet production requirements to bring your electrical system up to date. The result is a modern system integrated into your present plant setup.

FOR ADDITIONAL INFORMATION on how G-E engineered systems and engineering services can help you, contact your G-E Apparatus Sales Representative during your early planning at the nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y.

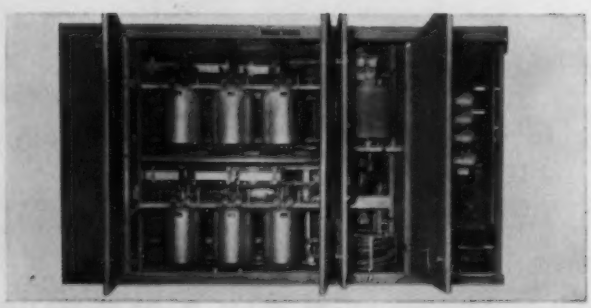
681-5

Engineered Electrical Systems for Process Industries

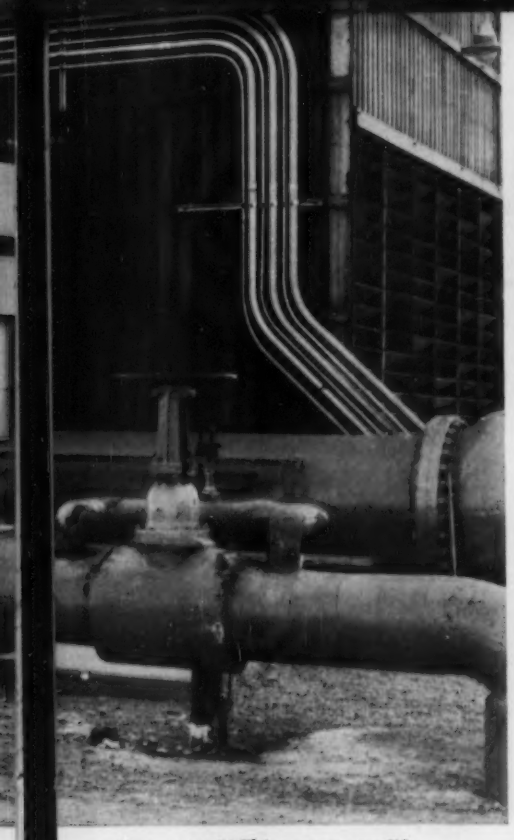
GENERAL ELECTRIC



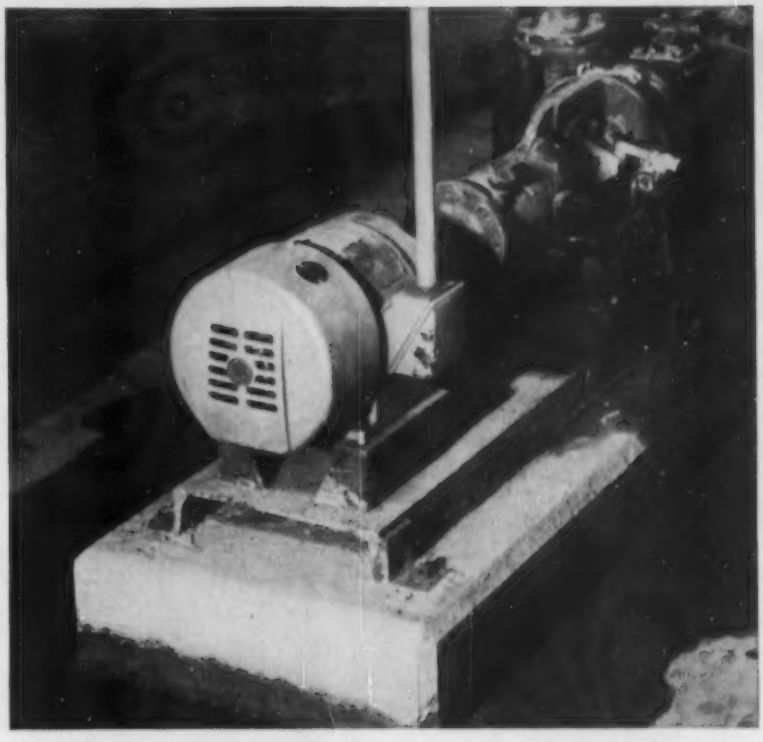
"BUILDING-BLOCK" design of this stack-rack capacitor block reduces installation costs. This design means equipment may easily be expanded or moved to meet plant requirements.



HIGH EFFICIENCY and low installation cost of this pumpless rectifier provide more reliable and economical d-c power. Factory wired, the unit is ready when it arrives to connect and operate.



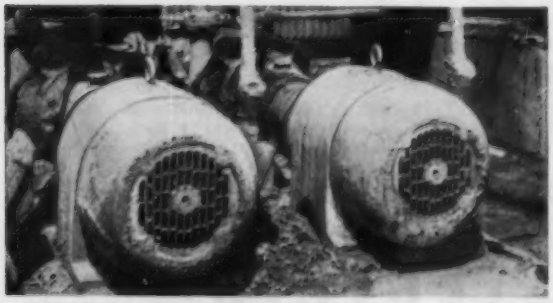
gives up to 50% longer motor life.



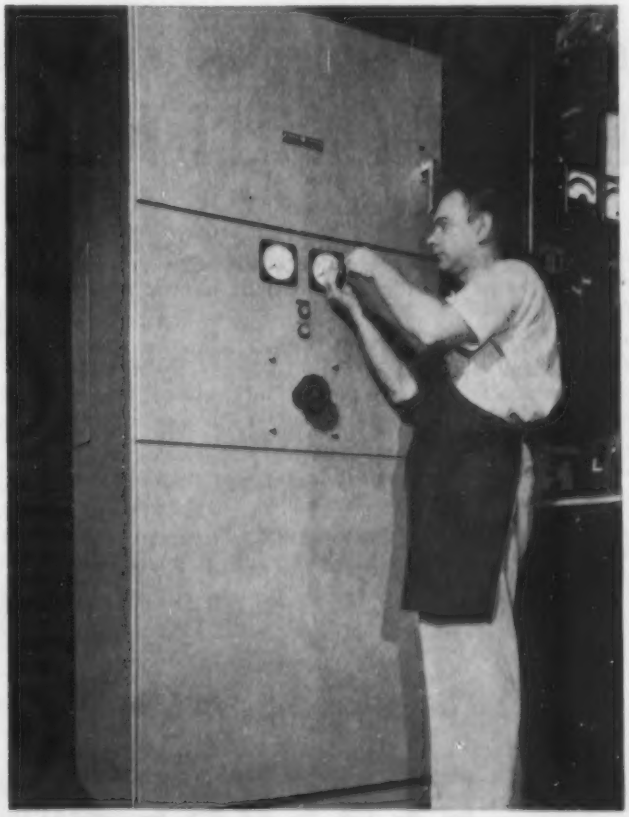
NEW G-E TRI-CLAD® '55' MOTORS, totally enclosed, are suitable for damp areas, even where hosing is necessary. New cooling system cleans while it cools motor.

for your plant

G-E MAGNETIC STARTERS and safety switches are compact, for maximum space savings. Short-circuit protection is provided by circuit breaker or fusible disconnect switch.



CORROSIVE ATMOSPHERE effects are greatly minimized in these G-E Tri-Clad induction motors. Rugged cast-iron construction makes them excellent for process application.



SHORT CIRCUIT PROTECTION up to 60,000 amps, plus 50% greater space savings are provided by all-new G-E Limitamp®.

Reg. Trademark of General Electric Company

SIX G-E ENGINEERING SERVICES . . .

HELP YOU PROTECT YOUR EQUIPMENT INVESTMENT

1 **G-E APPLICATION ENGINEERING** helps you and your consultants design the right electric system for your plant.

2 **G-E ANALYTICAL ENGINEERING** helps attain the optimum electrical system for your application. Engineering experience backed up by electronic system analyzers save valuable design time.

3 **G-E PRODUCT DEVELOPMENT** laboratories design and test new equipment under tomorrow's conditions to meet your future demands.

4 **G-E FIELD-SERVICE ENGINEERING** helps you supervise installation, expedite start-up of your major electric equipment.

5 **G-E MAINTENANCE SERVICE** from 36 G-E Service Shops will repair and uprate your old equipment, help establish productive maintenance of your equipment, furnish emergency service.

6 **G-E PROJECT CO-ORDINATION** means on-time engineering, shipment, installation of your electric equipment from preliminary diagrams through start-up.

These valuable services are available to you with General Electric equipment. Contact any General Electric Apparatus Sales Office. Meanwhile, for the full story of G-E engineering services, write for brochure GED-2244, General Electric Co., Section 681-5, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

What's Happening. . .

head of various committees and subcommittees of the American Society for Testing Materials. He is a graduate of the University of Texas.

Clarence E. Larson has been appointed vice president in charge of research for National Carbon Company, a division of Union Carbide and Carbon Corporation. He formerly was director of Oak Ridge National Laboratory, operated by Union Carbide for the government.

Larson

Dr. Larson will head all the affiliate's research activities, including Union Carbide's research in new physics, and be a member of the corporation's research committee. He will be stationed in Cleveland.

He was chairman of the Department of Chemistry at the College of the Pacific in 1942, when he joined the Manhatten Project at the University of California at Berkeley. He later became chief of the Analytical section.

The following year, he moved to Oak Ridge, Tenn., as head of the technical staff at the AEC's electromagnetic plant, later becoming director of reasearch and finally plant superintnedent. He was appointed director of the National Laboratory in 1950.

M. P. Venema, executive vice president of Universal Oil Products Company, has been elected a director of the company. Also named to the UOP board was **A. Nye Van Vleck,** recently-retired vice president of New York's Guaranty Trust Company.

Venema

With the company more than 20 years, Venema started as a junior chemical engineer and successively became a member of the patent staff, the company's patent representative in Washington, vice president and finally executive vice president.

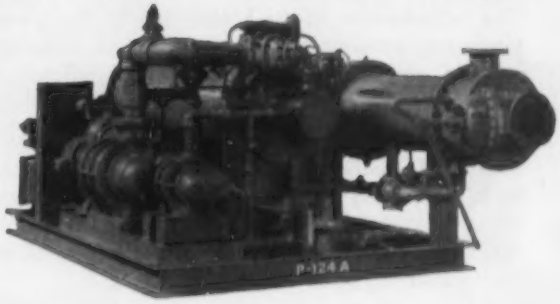
D. A. Sedgwick, with The Texas Company since 1936, has been elevated to assistant to the vice president in charge of the Industrial and Public Relations department. He will coordinate the company's college recruiting program, as well as the company's relations and universities.

Paul W. Bachman, formerly vice president in charge of research and development for Davison Chemical Company, has joined Koppers Company, Inc., as vice president and director of research and development. **Dr. E. W. Volkmann,** manager of Koppers' Research department since early this year, will continue in that position.

Dr. Bachman has been associated with General Chemical Company and Victor Chemical Company, and is a former direc-

The upper unit illustrated is a portable R-C Inert Gas Generator, oil-fired, with capacity of 35,000 cfh. The lower unit is a stationary type, gas-fired, with capacity of 50,000 cfh.

PROTECTION
at your finger tips
with
R-C INERT GAS GENERATORS



CHECK THE R-C
"BIG 4"
ESSENTIALS

1. **Compact units, portable or stationary**
2. **Choice of gas or liquid fuels**
3. **Low cost per cubic foot of capacity**
4. **Little supervision or maintenance**

You can find this combination of values only in R-C Inert Gas Generators.

Quick availability of smothering inert gas to reduce fire or explosion hazards not only protects against accident or property damage, but frequently results in lower insurance costs which often repay the cost of the equipment.

With R-C Inert Gas Generators, you can get fast action from either stationary or portable units. They can operate on either gas or liquid fuel, and their simple design permits instant readiness with little attention.

ASK FOR DETAILS

Ask the R-C engineer to point out where Inert Gas Generators can be used to advantage in your plant. Or, write for Bulletin 100-B-14.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.
755 Crescent Ave. • Connersville, Indiana
Roots-Connersville Blower (Canada) Ltd. • 629 Adelaide St. W., Toronto, Ont.

Centrifugal and Rotary Positive Blowers and Exhausters • Positive Displacement Meters • Vacuum Pumps • Gas Pumps • Inert Gas Generators • Spiroaxial Compressors

For more data on advertised products, use Readers' Service Cards, last page.

PIONEER AND LEADER
FOR 25 YEARS...

BS&B
Safety Heads

THE "CIRCUIT-BREAKER" OF
PRESSURED SYSTEMS

The introduction of the BS&B Safety Head some 25 years ago presented industry with an entirely new type of precision safety device designed to protect equipment wherever overpressure was a problem.

Down through the years many special and improved models of BS&B Safety Heads and rupture discs have been developed to take care of specialized applications. Thousands upon thousands of them are "on-the-job" today guarding pressured systems in virtually every type of industry.

From our stock of thin ductile metals (which is the widest assortment in the world assembled in any one place) we can fabricate over 95% of all rupture disc orders from materials on hand.

Typical Industries Which Use
BS&B Safety Heads:

Chemical Processing
Oil & Gas Production, Pipeline and Refining
Power Generation
Food Processing
Air Conditioning and Refrigeration
Transportation
Paper Mills
General Manufacturing

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-F10
7500 East 12th Street
Kansas City 26, Missouri

What's Happening. . .

tor of research and Technical division manager for Commercial Solvents Corporation. He joined Davison Chemical in 1949 as director of research and development, becoming vice president in 1952.

Lambert

Fitzgerald

Don E. Lambert has joined the Petroleum REFINER Staff as Management and Personnel editor, his appointment having become effective on September 22, Publisher Ray L. Dudley has announced.

For the past year and a half Lambert served as public relations assistant with The Carter Oil Company, Tulsa. Prior to that tenure, he had been editor of *Future*, the United States Junior Chamber of Commerce publication which has 225,000 circulation. He also served at one time as public relations director for the national Jaycees, being in charge of publicity and press relations for all national Jaycee events such as their national convention, Ten Outstanding Men of the U.S., National Teen-Age Road-eo International Jaycee Junior Golf tourney, etc. While with Carter he handled feature articles and publicity relating to all phases of the oil industry and also assisted in publication of *The Link*.

Lambert has a Bachelor's degree in journalism from the University of Missouri and completed 12 hours toward his Masters in Journalism at Northwestern prior to his withdrawal from college due to illness in his family. He has written for both United Press and International Feature Service and also has had radio news experience.

"We are happy that Don Lambert has joined our staff," Publisher Dudley declared. "He is a seasoned journalist, has had valuable experience in oil industry writing and we feel certain will handle our Management department in a creditable fashion."

Dudley also announced that **Wallace Fitzgerald** had been appointed managing editor of THE REFINER in which post he succeeds Silas B. Ragsdale who, since the first of the year, has also been Editorial Director. Fitzgerald is a veteran Gulf Publishing Company editorial man, having been assistant managing editor of *World Oil* and *Pipe Line Industry* for some time. He is a graduate of Texas Christian University, Fort Worth, and has worked on a number of Texas newspapers including the Galveston *Daily News*, the Houston *Post* and the Houston *Press*.

Robert M. Jackson has been given the job of coordinating the world-wide petrochemical operations of Standard Oil Company (New Jersey). He will serve as an assistant coordinator in the Refining Coordination department in charge of chemical products.

With the company 21 years, Jackson started his petroleum career as a refinery

Two CHEMICO - designed plants

produce over 900 tons per day of anhydrous ammonia for Lion Oil Company

Production volume at the El Dorado Chemical Plant reached an all time high in 1954. Total of all nitrogen products manufactured for sale increased 10 per cent over the previous year.

Anhydrous ammonia, which is the basic product of the plant and the raw material for the manufacture of other nitrogenous materials, was produced at an average rate of 582 tons per day throughout the year. The comparative figure for 1953 was 576 tons daily with the same equipment.

Extracts from the 1954 Annual Report of Lion Oil Company, referring to Plants designed by Chemico to produce 900 tons per day of anhydrous ammonia and corresponding amounts of nitric acid and ammonium nitrate.

The Barton Plant near New Orleans, Louisiana, was completed in June, 1954, after a construction period of about 18 months. The manufacturing facilities were gradually brought up to full production and operated at rates above the designed daily capacities of 300 tons of anhydrous ammonia, 430 tons of nitric acid and 550 tons of pelleted ammonium nitrate. This plant was formally dedicated on October 25, 1954, in ceremonies attended by employees, their families and many guests.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

Designers and constructors of complete plants and facilities for the chemical, metallurgical and petrochemical processing industries for over 40 years

525 WEST 43RD STREET, NEW YORK 36, NEW YORK

Cable Address: Chemiconst, New York • Technical Representatives: Cyanamid Products Ltd, London South African Cyanamid (Pty) Ltd., Johannesburg

CC 289

CHEMICO

CHEMICO CHEMICAL CONSTRUCTION CORPORATION

clean separation

In any process vessel handling both liquid and vapor phase materials:

- Separation efficiencies better than 99.9% are generally obtained in process vessels.
- Higher vapor velocities can be used.
- Pressure drop is negligible — in most cases amounting to a fraction of an inch water gauge.

Yorkmesh DeMisters — knitted wire mesh entrainment separators and mist extractors with 98% or higher free volume are low in cost and economical to install in new or existing equipment. Accurately made to fit your equipment, in all materials of construction. Results are improved process efficiency, greater throughout capacity, and higher overhead quality.

We'll be pleased to study your needs and make recommendations.

For further facts, write for Bulletin 16.

AMAZING — but simple

Liquid droplets entrained in the vapor stream are impinged on the extensive wire mesh surfaces. The fine droplets coalesce and the liquids drain free. The clean vapor passes overhead.

Yorkmesh DeMisters provide clean separation between liquid and vapor in:

Vacuum Towers • Distillation Equipment
Gas Absorbers • Scrubbers • Evaporators
Knock-Out Drums • Steam Drums

YORK

OTTO H. YORK CO., INC.
6 Central Avenue, West Orange, N. J.
"clean separation between vapor and liquid"

What's Happening. . .

foreman at Wichita, Kansas. He joined the Jersey Standard organization in 1934, and since then has held progressively higher positions in refining, engineering and petrochemicals.

Murray Bloch Chenicek

Vladimir Haensel has been appointed director of refining research for Universal Oil Products Company, with **Herman S. Bloch** named to serve as deputy director. Others receiving new appointments in the company's research staff were **J. A. Chenicek**, made director of chemical research, and **M. J. Murray**, the new director of physics research.

Haensel

S. H. Simpson, Jr., former manager of communications research for Southwest Research Institute, has been made assistant vice president concentrating on coordinating the institute's research program.

William A. Mussen, supervisor of research and development in several fields, was made chairman of a new Electrical Engineering department, and **James Sharp,** who had been manager of special physics projects, was named chairman of the Physics department.

C. A. Stokes has been elected vice president and technical director of Texas Butadiene & Chemical Company. For the past ten years, Dr. Stokes has served as director of research and development for Godfrey L. Cabot, Inc., Boston carbon-black and chemical manufacturing firm.

Stokes

A director of Petrocarb, Inc., Dr. Stokes has been active in AIChE affairs at both the local and national levels and is past chairman of the Ichthyologists, the Boston section of AIChE. He is a director of the Industrial Research Institute.

R. C. Woerner has been named director of the Process Engineering and Design department of Petro-Tex Chemical Corporation. As head of the newly-created department, he will be in charge of work to increase the efficiency and output of the company's butadiene plant at Houston.

Formerly general superintendent, Woerner joined the company when it acquired the plant from the government. He had

for extra-long life...

specify *FLUOR* Cooling Towers

with FLUOR-WESTERN Speed Reducers

A Fluor cooling tower's outstanding performance is the result of a combination of carefully engineered components. Take for instance the Fluor-Western Speed Reducer installed only on Fluor Cooling Towers. Designed and engineered by specialists in the mechanical power transmission field, these speed reducers have built-in superiority... illustrated by an analysis of the chart below:

...and here are the reasons why...

	FLUOR	A	B	C	D	E
1. Case-hardened spiral gear	yes	yes	yes	yes	no	yes
2. Ratings based on 1.5 AGMA service factor	yes	no	yes	yes	no	yes
3. Straddle mounted pinion gear	yes	no	no	yes	yes	no
4. Webless-type ring gear	yes	yes	no	yes	no	yes
5. B-10 bearing life (in hours)	80,000 to 2,000,000	50,000	20,000	80,000 to 100,000		5,000
6. Condensate trap	yes	no	yes	yes	no	yes
7. Double neoprene seals (input shaft)	yes	no	no	no	no	no
8. Two oil-fill elbows	yes	no	no	no	no	no
9. Efficiency	98%	98%	98%	98%	90-95%	98%

Each Fluor-Western Speed Reducer is thoroughly tested for noise level and horsepower rating before leaving the factory.

The bell-shaped housing on Fluor-Western Speed Reducers is low, wide, and offers a good sturdy support for fan.

EXPLANATION OF CHART

1. Over the years, case-hardened spiral bevel gears have proved to be far superior to worm gears or flame-hardened bevel gears.

2. The Fluor-Western Speed Reducer is designed and rated in accordance with the applicable standards of the American Gear Manufacturers' Assn. and utilizes a minimum service factor of 1.5 for continuous service.

3. The Fluor-Western pinion is straddle-mounted on heavy-duty bearings. Uniform tooth contact, quieter operation, minimum deflection are the advantages.

4. Deflection tests on ring gears prove conclusively that webless ring gears which utilize a maximum diameter hub are much more rigid than web-mounted gears.

5. Most gear failures are traced to bearing failure. The majority of bearings in the Fluor-Western Speed Reducer have a B-10 life in excess of 100,000 hours. At certain ratios and speeds bearing life can be considered infinite.

6. A condensate trap collects entrained water inside the gear unit caused by condensation, thus protecting the lower bearing from improper lubrication.

7. Two Neoprene seals mounted back to back on the input shaft, with grease between (to keep foreign matter out and oil in), are found only on the Fluor-Western unit.

8. Only Fluor-Western units have the servicing convenience of two oil-fill elbows; one is piped outside the fan stack for easy filling, the other provides a positive check for proper oil level.

9. Efficiency ratings are based on actual gear mesh loss. Fluor-Western spiral bevel gears average around 1% to 2% loss while competitive worm gears show a loss of 5% or greater.

A COOLING TOWER EVERY 3 DAYS

In the past decade (1944 through 1954) Fluor has built 1,218 induced draft cooling towers throughout the world—**an average of one new tower every three days.** The total number of cells in these towers adds up to 3,138 which represents 3,138 individual gear reducers ranging in sizes from 15 to 100 horsepower ratings. The extra long gear and bearing life of Fluor-Western Speed Reducers is an important factor in the overwhelming preference for Fluor Cooling Towers. The Bulletin, "Cooling Water for Industry," will be mailed on request.

MEMBER CTI COOLING TOWER INSTITUTE

BE SURE WITH

FLUOR

THE FLUOR CORPORATION, LTD.
LOS ANGELES 22, CALIFORNIA, U.S.A.
FLUOR OF CANADA · TORONTO
HEAD WRIGHTSON · LONDON
AFFILIATES: BINGHAMTON & BOWER, NEW YORK; H. G. ACHES & COMPANY, LTD., NIAGARA FALLS, ONTARIO, CANADA

ENGINEERS · CONSTRUCTORS · MANUFACTURERS

NEW YORK · CHICAGO · PHILADELPHIA · BOSTON · PITTSBURGH · SAN FRANCISCO · HOUSTON · BIRMINGHAM · TULSA · DENVER

For more data on advertised products, use Readers' Service Cards, last page.

FLOORED BY FLOORING PROBLEMS

YOUR SOLUTION IS IRVING GRATING

For heavily abused areas:

IRVING Continuity Armouring

concrete-filled steel grating floor will not crack or break up. Inexpensive to install, it eliminates costly repairs AND IS SAFE.

Non-Sparking and Corrosion-Resistant ALUMINUM GRATING

extra-light, self-draining, self-ventilating, economical, strong and durable.

Perfect for Chemical Plants where fire is a hazard.

★

Ask about

IRVING "GRIDSTEEL"

CONTOUR RETAINER MESH

for Castable Ganister Linings used in refractionating units.

IRVING SUBWAY GRATING CO., INC.

ESTABLISHED 1902

OFFICES and PLANTS at

5090 27th St., Long Island City 1, N. Y.

1890 10th St., Oakland 20, California

been with the previous operator, Sinclair Rubber, Inc., and held positions in New York, Harvey, Ill., and Houston with Sinclair Refining Company.

Four other longtime employes at the plant received new appointments. **Dilmas V. Fitz**, former assistant general superintendent, was promoted to succeed Woerner as general superintendent, and **H. A. Harrison** was moved up from production superintendent to process superintendent. He also will serve as assistant general superintendent.

Replacing Harrison is **C. Herbert Sloan**, promoted from administrative assistant. **Walter A. Myrick, III**, formerly senior chemical engineer, is the new administrative assistant.

F. O. Newton has been elected to a newly-created position as vice president of Universal Oil Products Company with responsibility for supply and distribution. And **W. J. Peck** has been named an assistant secretary of the company.

Newton

With UOP more than 20 years, Newton started as a member of its Pilot Plant division and became, successively, a member of the Service and Commercial Development departments. For the past ten years, he has engaged in special project work, and since July 1952, he has been assistant to the executive vice president.

Peck, a member of the legal staff, has been with the company since 1953. Before joining UOP he was assistant U. S. attorney for the District of Columbia in charge of the Appellate section.

Jacob Blaustein has been re-elected to the board of Standard Oil Company (Indiana). He earlier became a director in August 1954, in accordance with the terms of the merger of Pan American Petroleum & Transport with Standard. He had long been a director of Pan American and a substantial owner of its stock. In accordance with the merger agreement Blaustein resigned as a director of Standard at the end of one year's service.

Stewart P. Coleman, a director of Standard Oil Company (New Jersey) since 1946, has been elected a director of the company. Coleman, a chemical engineer, started with the affiliated Humble Oil & Refining Company in 1920.

He joined the parent company in 1933 as coordinator of manufacturing and in 1940 became manager of the Coordination and Economics department. From 1942 to 1945 he was in government service, first with the Petroleum Industry War Council and later with the Petroleum Administration for War.

Courtlandt F. Denny, with Foster Wheeler Corporation, has been appointed director of the Power Equipment division under the Department of Commerce's Business and Defense Services Administration. Denney, who is assigned regularly to Foster Wheeler's Research and Development staff, was named to the job for six months. He joined the company in 1927 as an operating engineer in charge of putting distillation units into operation.

What's Happening. . .

Herbert R. Jensen, professor of education and director of the Instructional Materials Center at Colorado State College of Education, is joining the API's staff as supervisor of educational activities. He will assume direction of the institute's school program, under the jurisdiction of **H. B. Miller**, director of the Department of Information.

The school program involves preparation and utilization of educational materials on the oil industry, designed to supplement classroom studies. More than 6000 secondary schools are using API materials, and plans are underway to add another 3000 or 4000 schools to the program.

Peter J. Manno and **Christopher J. O'Shea** have joined the Catalysis section of The M. W. Kellogg Company's Petroleum and Chemical Research laboratory. Both recently received Ph. D. degrees in physical chemistry from Purdue University.

David L. Yabroff has been named manager of the Market Development department of Shell Chemical Corporation in New York. For the past two years he has been director of Shell Development Company's Agricultural Research division in Denver.

Dr. Yabroff joined Shell Development in 1934 as a research chemist at the research center in Emeryville, Calif. In 1948 he became an associate director in the company's Research division and two years later was made director of the Development division. He was named manager of manufacturing research with Shell Oil Company in 1951.

Succeeding Dr. Yabroff in Denver will be **S. H. McAllister**, an associate director in the Research division at Emeryville since 1942.

G. B. Hunter, president of Quaker State Oil Refining Corporation, has been elected president of the National Petroleum Association. He succeeds **A. W. Scott**, president of Wolf's Head Oil Refining Company. Hunter also was re-elected treasurer.

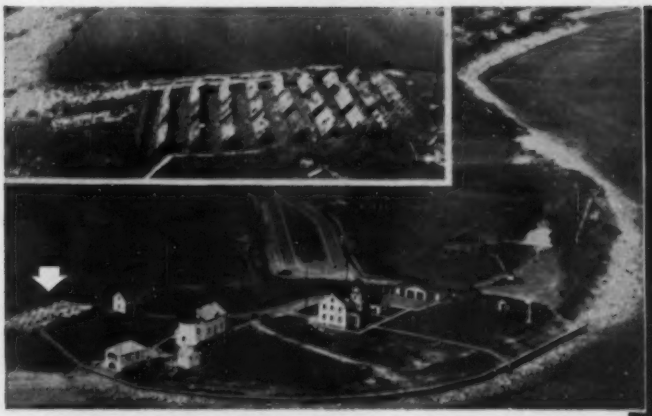
Others taking office in the association of oil refiners were **Paul R. Beck**, president of Pennsylvania Refining Company, and **Rex S. Blazer**, president of Ashland Oil & Refining Company. Beck was moved up to first vice president, and Blazer replaced him as second vice president.

Allen Myra has been appointed managing director of Standard-Vacuum Oil Company's refining subsidiary in Bombay. He succeeds **W. A. Williams** who has returned to the company's New York office for a new assignment.

Myra

Myra joined Standard-Vacuum Refining Company of India, Ltd., in 1952 as general superintendent and became a director a year later. The company owns and operates a $32-million refinery near Bombay, completed last year.

A Canadian citizen, Myra began his re-



POINT JUDITH, RHODE ISLAND

Aerial view and close-up (inset) of ALCOA'S seacoast exposure station at Point Judith. The station is located on a stony beach about 300 feet from the water's edge. Test specimens face south into prevailing winds from the ocean. Corrosion conditions are considered severe. [Aerial photo—courtesy of Providence (R.I.) Sunday Journal.]

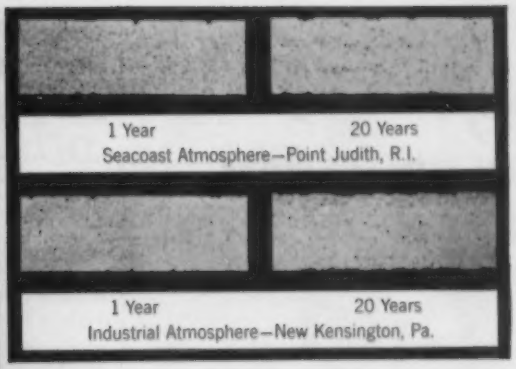
There are other seacoast exposure stations at Wilmington, N.C.; Miami, Fla.; Golden Gate, Calif.; Georgetown, Br. Guiana; Pitcairn Island, Br. Oceania; and La Jolla, Calif.

20-year exposures prove ALCOA Aluminum resists weathering

During the past 25 years, ALCOA research laboratories have exposed many thousands of ALCOA Aluminum alloy specimens to atmospheres in many localities in this and other countries. One of the initial comprehensive investigations, started 20 years ago, involved exposure of approximately 25,000 individual test specimens. These and subsequent investigations on newer alloys are now sufficiently inclusive to demonstrate convincingly the superior weathering characteristics of ALCOA Aluminum when subjected to a wide variety of conditions, including industrial, seacoast and tropical environments.

ALCOA's coordinated research and development program is geared to help you with *your* specific problem . . . to show you where and how ALCOA Aluminum can be used most effectively in your operation.

Write today for all the facts. They're in the new, FREE double reprint, *Resistance of Aluminum Alloys to Weathering* and *Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*. Use the coupon below to obtain your copy. We also have a new booklet, *Aluminum Pipe and Fittings*. Send for it.



Micrographs of full cross sections of 0.064-inch thick sheet of alloy 3003 after exposures indicated. Note that the corrosion develops at isolated spots, slowly spreads to new sites but is not appreciably deeper after 20 years than after one year. This pattern is typical for other corrosion-resistant ALCOA Aluminum alloys, such as 3004, 5050, 5052, 5154 and 6061.

NEW KENSINGTON, PENNSYLVANIA

Atmospheric exposure racks are located on the roof of the Aluminum Research Laboratories near laboratory exhaust vents. The atmosphere is similar to that at Pittsburgh, Pennsylvania. There are other industrial exposure stations at Edgewater, N.J., and St. Louis, Mo.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America
905-K Alcoa Building
Pittsburgh 19, Pennsylvania

Please send me your new, FREE reprint, *Resistance of Aluminum Alloys to Weathering* and *Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*, and *Aluminum Pipe and Fittings*.

Name_____
Company_____
Address_____
City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

Investigate

The Possibilities In Your Processing!

Tennessee's

SO_2 LIQUID SULFUR DIOXIDE

The Economical And Efficient SOLVENT!

This versatile chemical is particularly suitable as a solvent for recovery of aromatics. Liquid Sulfur Dioxide is completely miscible with aromatic hydrocarbons over a wide temperature range, while the solubility of napthene and paraffin hydrocarbons is limited and decreases with decreasing temperature. Recovery of a higher percentage of aromatics is obtained for hydrocarbons over a wide boiling range.

SULFUR-DIOXIDE HIGHEST QUALITY SO_2

Let our experienced technicians advise you on the use of Tennessee's Liquid Sulfur Dioxide in your processing.

AVAILABLE IN: Cylinders, Ton Drums, Tank Trucks and Tank Cars.

TC

TENNESSEE CORPORATION

617-629 Grant Building, Atlanta, Ga.

What's Happening. . .

fining career in 1934 at the Halifax refinery of Imperial Oil, Ltd., serving successively as chemist, process engineer and head of the Process Control department.

After an assignment in Imperial's executive offices at Toronto, he went to Edmonton as a process engineer engaged in all phases of construction, organization, start-up and operation. He continued there until he joined Stanvac.

Neal B. Prichard, formerly general superintendent of refineries for Anderson-Prichard Oil Corporation, has been elected vice president in charge of manufacturing. He succeeds **George H. Burruss,** who retired after directing the company's refining operations for 29 years.

Prichard

Named to replace Pritchard was **J. C. Brady,** former superintendent of the Anderson-Pritchard refinery in Arkansas, City, Kansas. He entered the company's employ in 1939 and since then has served as superintendent at each of its three refineries.

Pritchard, a nephew of the company's co-founder, joined the firm in 1931 at its Colorado City, Texas, refinery. He was made superintendent there in 1938, and in 1946 was transferred to the general office in Oklahoma City to assist Burruss.

F. D. Parker, former manager of Blaw-Knox Company's Chemical Plants division in Tulsa, has been elected vice president in charge of manufacturing for Arthur G. McKee & Company's Petroleum division. He will headquarter in Cleveland.

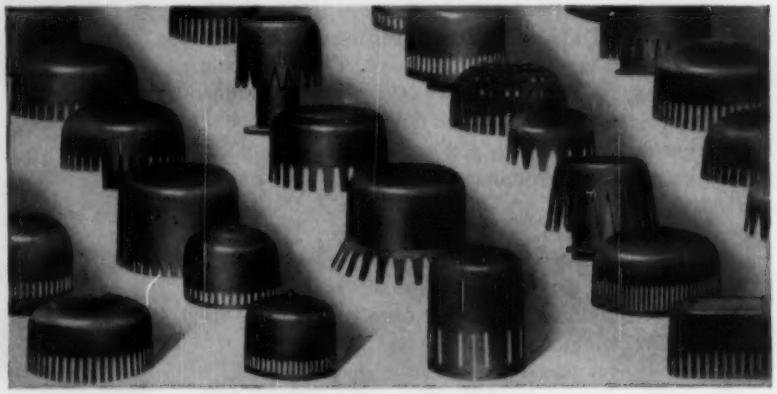
Parker

Parker started his career in the petroleum and chemical industries with Union Oil Company of California in 1937, and during the early years of World War II served as a process engineer for the Office of Petroleum Coordination. He left government service to join Bechtel Corporation as chief process engineer.

He later formed his own firm of consulting engineers on the Pacific Coast and represented Houdry Process Corporation in the western states. Four years later he became associated with Badger Process Division of Stone & Webster Engineering Corporation.

H. M. Davidson, for ten years Standard-Vacuum Oil Company's refining coordinator, has retired after 34 years in the industry. For the past year he had devoted his time to the development of petrochemicals.

S. B. Schapiro, manager of engineering construction and maintenance for The American Oil Company, and **Harold R. Snow,** vice president in charge of manu-



SEND FOR PSC

BUBBLE CAP BULLETIN 22

Largest Compilation of Engineering Data.

Lists 300 Styles Furnished Without Die Cost.

This standard reference on bubble caps and risers contains complete specification information for hundreds of variations. Also many drawings for use in determining methods of tray assembly. With dies on hand for all listed styles, PSC can save you substantial die costs as well as design and delivery time. Furnished in any drawing type of metal, to meet your coking or corrosion problems. Assemblies will also be produced to your specifications.

THE PRESSED STEEL CO., 715 N. Penna. Ave., Wilkes-Barre, Pa.

PSC

Custom Fabricators for the Process Industries Since 1928. Send Your Blue Prints.

DRY DISTILLATION IS FEATURE OF SIGNAL'S TIOGA PLANT DESIGNED AND ENGINEERED BY PRITCHARD!

Signal Oil and Gas Company's new Tioga, North Dakota, natural gasoline plant features dry distillation, with no steam used in the gasoline recovery process.

The entire plant was designed and engineered by Pritchard for extreme cold weather operation, with temperatures —40° F or below.

Here is another in the long parade of successful Pritchard installations — proof that Pritchard has the skill to design and engineer *your* refinery or natural gasoline plant.

INDUSTRY'S PARTNER FOR PROGRESS

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

BOSTON, BUFFALO, CHICAGO, HOUSTON, NEW YORK, PITTSBURGH, ST. LOUIS, TULSA

J.F. Pritchard & Co.

ENGINEERS & CONSTRUCTORS

Dept. 472 · 4625 Roanoke Parkway, Kansas City 12, Mo.

A. O. Smith reports

Important applications for nondestructive tests are those that determine acceptability of materials for specific corrosion-resistant or welding characteristics. Sulphur printing, illustrated here, is one of the control inspections used by A. O. Smith. The test is designed to determine the amount and segregation of sulphur present in forgings. This inspection evaluates the forging for welding.

on nondestructive testing

Still another method of flaw detection used by A. O. Smith is the magnetic particle test. Magnetic particle tests are ideal for detecting surface and sub-surface faults in ferrous materials. In this picture, technicians are shown inspecting the welds on a pressure vessel.

Ultrasonic testing (inspection utilizing high-speed sound waves) is another method A. O. Smith uses for quality control of heavy sections. The picture shows an additional application of ultrasonic testing — operator is determining wall thickness of 167,000-lb. vessel.

Nondestructive inspection is one more reason for the dependability of A. O. Smith vessels, exchangers and other process equipment.

The man in charge of A. O. Smith's nondestructive testing . . .

A. Cota. With A. O. Smith for more than 27 years, Mr. Cota has specialized in nondestructive testing since 1932. He has been a leading force in the development of many of the techniques and procedures now used throughout industry. He is past-president of the National Society for Nondestructive Testing . . . is serving on nondestructive testing committees of ASME and ASTM and on various other control groups. This experience is another reason why it's wise to call A. O. Smith first for processing equipment.

Illustrated here are just a few of the nondestructive testing processes by which A. O. Smith maintains the quality of its products. Of course, there are many other tests, too — both nondestructive and destructive — all designed to help create equipment that will excel in your operations.

A. O. Smith was one of the members of the original committee that first established radiographic inspection techniques and standards. Also, we have used magnetic particle testing since 1934 . . . ultrasonic testing procedures since 1945.

Through research A.O. Smith *. . . a better way*

A.O.Smith

CORPORATION

PROCESS EQUIPMENT DIVISION
HEAT EXCHANGERS • PRESSURE VESSELS
Milwaukee 1, Wisconsin

International Division: Milwaukee 1, Wisconsin

☑ *what* do you want to see?

☐ **WATER LEVEL?**

Pressures to 100 p.s.i.—CORNING brand STANDARD gauge glasses. To 300 p.s.i., and high temperatures—PYREX brand HIGH-PRESSURE gauge glasses. To 300 p.s.i., and corrosive conditions—PYREX brand HEAVY-WALL gauge glasses. For greater visibility—PYREX brand RED-LINE gauge glasses. 350 to 5000 p.s.i. (and higher in some cases)—MACBETH brand FLAT gauge glasses.

☐ **INTO HIGH-PRESSURE, HIGH-TEMPERATURE VESSELS?**

PYREX brand SIGHT GLASSES give you typical advantages of PYREX brand glass No. 7740—high thermal shock resistance, chemical stability, physical stamina, clear visibility, resistance to clouding.

☐ **LUBRICATION LEVELS, OIL LEVELS?**

PYREX brand lubrication and oil-cup glasses—long-lasting, chip-resistant, easy to install. Accurate dimensions insure a snug fit.

Your Industrial Distributor has a complete line of Corning quality gauge glasses—let him help you select the types which will best serve your needs. Call him today.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	*Recommended Product*
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Viewing inside furnaces, reactors pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York

Corning means research in Glass

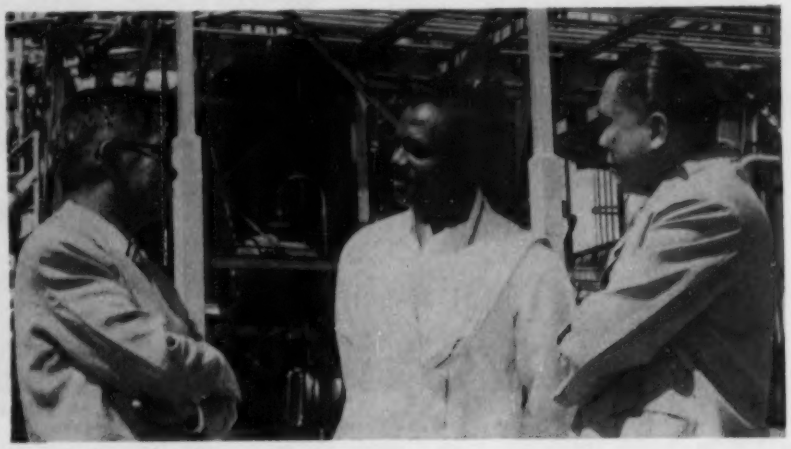
What's Happening. . .

facturing, have completed 30 years with the company. Schapiro is directing the building of American Oil's new $30-million refinery near Yorktown, Va.

Robert B. Anderson, recent Deputy Secretary of Defense, has been elected president of Ventures, Ltd., world-wide mining and development company.

Fred Holloway has been appointed assistant general manager of Esso Standard Oil Company's East Coast Manufacturing division. He will be succeeded as assistant general manager at the company's Baton Rouge, La., refinery by **Donald W. Swan,** former general superintendent.

With Esso Standard since 1939, Dr. Holloway served first as an engineer at Baton Rouge, later holding posts as head of the Chemical Technical Service department, head of the Technical division and general superintendent of the refinery. He



Tour Richmond Refinery—

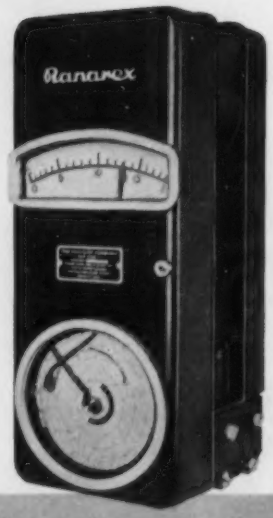
All the U.N. activity wasn't at the Opera House during the recent commemorative session in San Francisco. Above, three Caltex oil marketing trainees are shown inspecting the residuum stripper at Richmond Refinery of Standard Oil Company of California. Left to right, Lauriano Arcadio, Manila; Herbert Rajaih, Madras, India; Liang Viriasiri, Bangkok, Thailand.

RUGGED H_2 INDICATOR
for catalytic reformers

Works on a simple, mechanical principle using specific gravity to measure H_2 in reformer recycle gas. Low cost. Instant response. Local or remote readings. Replaces expensive, delicate instruments that "can't take it."

Other uses: Measuring specific gravity of refinery fuel gas, off-gases from cracking furnaces, demethanizers, etc. and for gas blending . . . also analyzing boiler and heater flue gases to cut fuel costs.

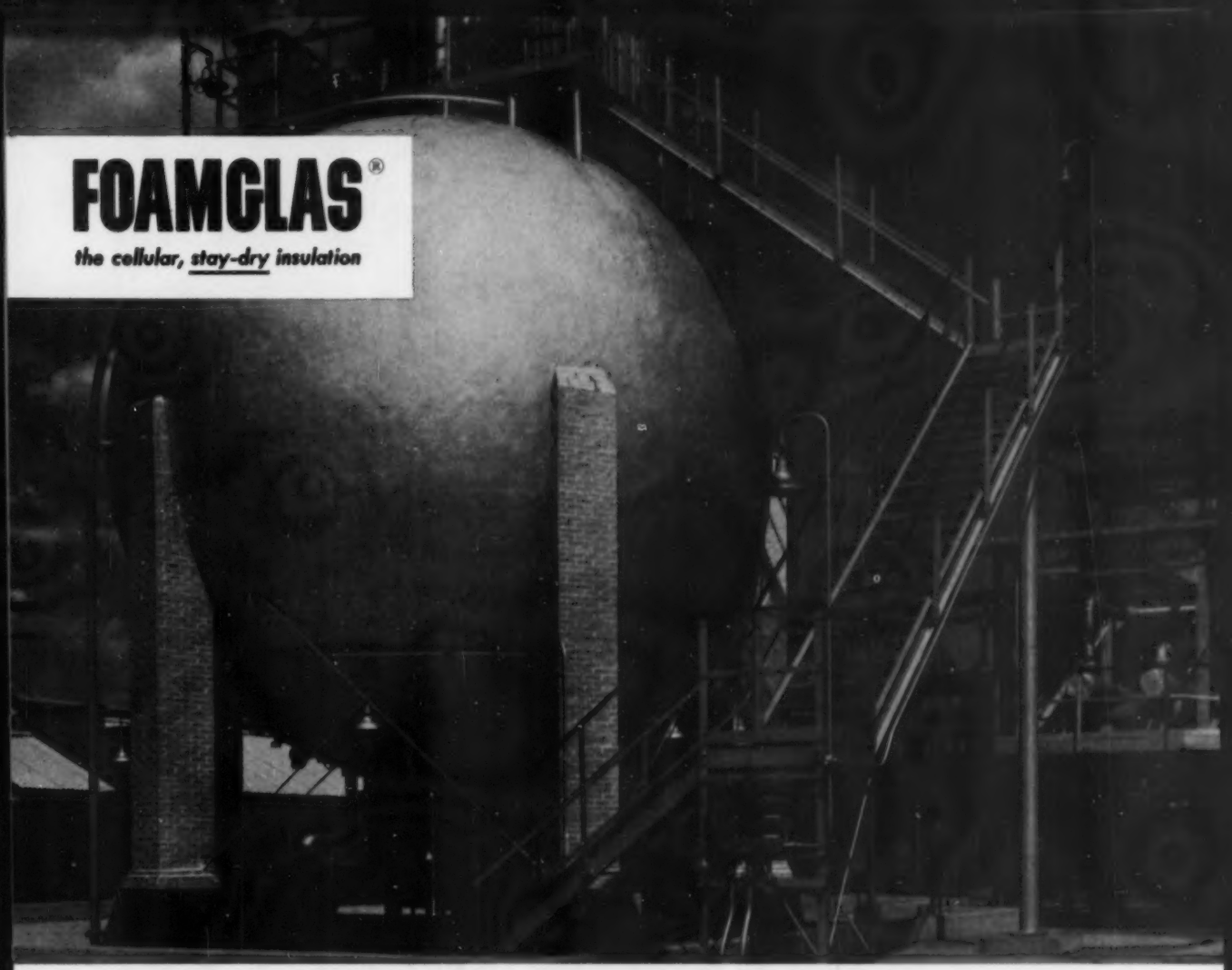
For details write to The Permutit Company, Dept. PR-10, 330 West 42nd St., New York 36, New York.



RANAREX®

FOAMGLAS®

the cellular, stay-dry insulation



Insulation Contractor: Combustion Equipment & Insulation Co., Cleveland, Ohio

SOHIO gets efficient desalting because . . .

Spillage-proof FOAMGLAS insulation stays effective to hold precise temperature

Efficient electric desalting to remove salts and other impurities from crude charging stocks demands precise temperature control throughout the process. The influent temperature (180° F to 220° F depending on viscosity of crude) must be held constant until effluence. Since there's no exchange of heat inside the sphere, it must be insulated very effectively.

For six years Standard Oil Company (Ohio) has maintained peak desalting efficiency by insulating their spheres in Cleveland, Lima and Toledo with FOAMGLAS. This unique cellular glass insulation benefits SOHIO three ways:

1. **Spillage-proof,** moisture-proof FOAMGLAS retains its insulating value . . . avoids fire hazard.
2. **Easy-to-apply** FOAMGLAS blocks are lightweight but very strong, readily applied to sphere, eliminating insulation supports.
3. **Effective insulation** holds temperature required for electric field to break continuously the water and oil emulsion. It also prevents temperature drop near vessel wall . . . avoids thermal currents which would interfere with process.

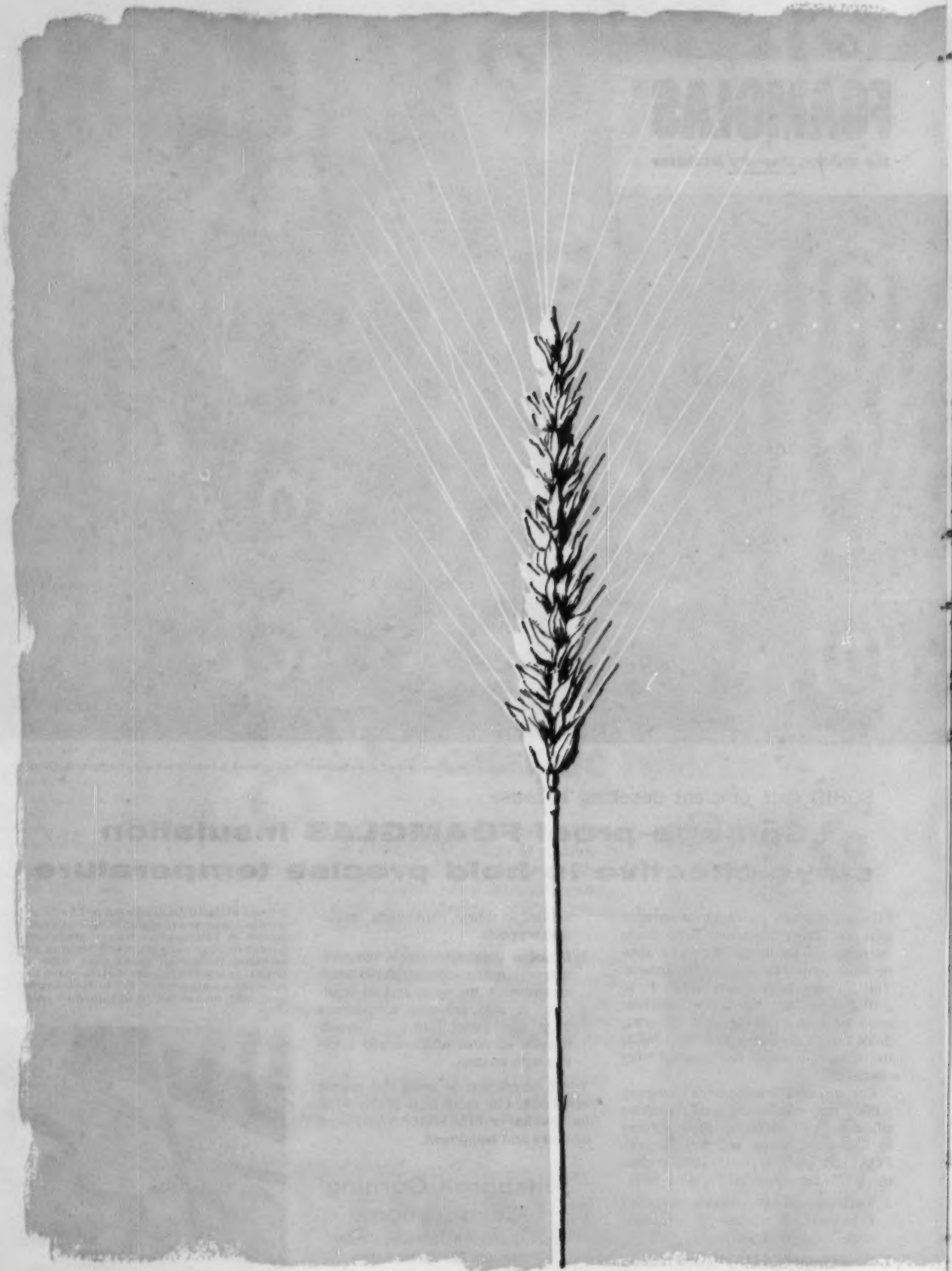
You'll benefit too by using this unique insulation. For more facts please write for booklets on FOAMGLAS for piping or tanks and equipment.

Pittsburgh Corning Corporation

Dept. Z-105, One Gateway Center
Pittsburgh 22, Pennsylvania
In Canada: 57 Bloor St. W., Toronto, Ontario

Visit our booth at the CHEMICAL SHOW, Philadelphia, December 5th to 9th

2" thick FOAMGLAS blocks cut to 12 x 12 size were laid diamond shape on SOHIO'S desalter sphere in Toledo. Two Nelson studs were welded through each block and secured with recessed Tinnerman speed clips. After asphalt cutback (Insulmastic 4010)—glass fabric—cutback application, the surface was finished with an asphalt base aluminum paint.



. . . OF SOUP, SACCHARIN, AND SUDS

What's in a drop of oil? Petroleum chemistry has found the answer to be without limits.

With petrochemicals, great strides have been made in producing better insecticides and pesticides, thereby enhancing the world's food supply. Petrochemicals brought about the successful synthesis of pharmaceutical compounds, making possible the mass production of life-saving drugs. New building materials . . . synthetic fibers and detergents . . . all of these are the results of continued research in the field of petrochemicals.

To make a great part of these successes possible required from petroleum sources the availability of large quantities of high purity benzene, toluene, and xylenes. These aromatics are now produced in exceptionally high purity and large amounts by the UOP Platforming process and are separated by the Udex process, this latter process developed cooperatively by Dow Chemical Company and Universal Oil Products Company and engineered and licensed by UOP. With these processes a ready supply of aromatics will always be assured.

Unheard of only a short time ago, these developments have become just the beginning for an unlimited future.

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

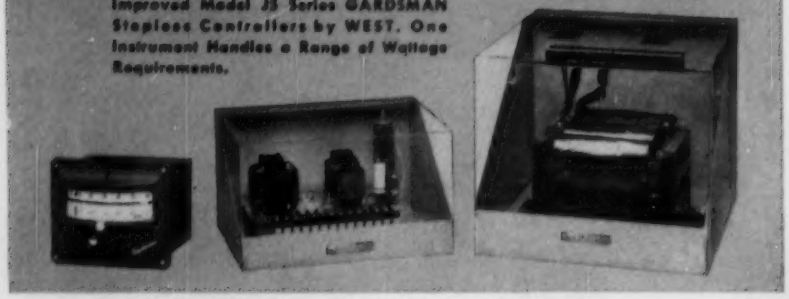
UOP *Universal Service Protects Your Investment*

For more data on advertised products, use Readers' Service Cards, last page.

Stepless temperature Control

NOW! TUBELESS, MULTI-LOAD

Improved Model J5 Series GARDSMAN Stepless Controllers by WEST. One instrument Handles a Range of Wattage Requirements.



★ Closest Control
★ Save power
★ Prolong Heater Life
★ Adjustable Band
★ Manual Reset
★ Simplest Operation—One Knob
★ Least Maintenance

Without tubes or relays, this unique instrument modulates input to suit demand. Proved in wide use. Write for Bulletin J5.

43578 W. Montrose Ave.
Chicago 41, Illinois

WEST *Instrument*
CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

INSTALL

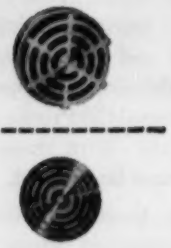
peak performance

INTO YOUR

compressors

(AIR • GAS • AMMONIA)

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.



Check **THESE VOSS VALVE ADVANTAGES:**

- Quiet, vibration-free operation
- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- normal discharge temperature
- lower operating costs
- utmost safety

Our detailed proposal for increasing the efficiency of your compressor will be sent you without obligation. Send us the name, bore, stroke, and speed of your machine.

J. H. H. VOSS VALVES
REG. U.S. PAT. OFF.

VOSS VALVES / J. H. H. VOSS Co., Inc. 785 East 144th Street, New York 54, N. Y.

What's Happening. . .

was named assistant general manager of the plant in 1954.

Swan, who was head of the Technical Service division at Baton Rouge before his appointment as general superintendent, joined the company in 1939.

The East Coast division is made up of Esso refineries in New Jersey, Massachusetts, Maryland, South Carolina and Pennsylvania.

Dravnicks Roop | Kapff Bland | Wygant Bulkley

Six Promoted

Standard Oil Company (Indiana) has appointed six men to head sections in its Engineering Research department at Whiting, Ind.

W. L. Bulkley, senior project engineer since 1953, was named to head the Equipment Development section. He joined Standard as a research engineer in 1947.

S. F. Kapff, who started with the company as a project physicist in 1948, was given charge of the Instrument Development section. Dr. Kapff has moved up to senior project physicist in 1951.

F. C. Roop, who became a senior project engineer earlier this year, was made head of the Applied Mechanics section. With the company since 1948, Dr. Roop started as an assistant project engineer.

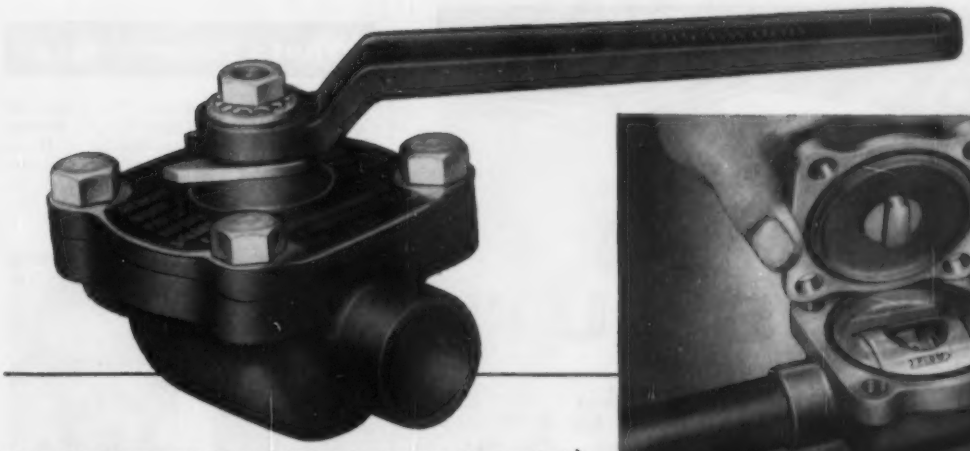
Julius Bland, a senior process engineer with Standard since 1951, was appointed head of the Materials division's Service Metallurgy section.

Andrew Dravnicks, also in the Materials division, was named head of the Corrosion section. He joined the company in 1949, and in 1953 was promoted to senior project engineer.

J. F. Wygant, with Standard since 1950 and advanced to senior project engineer four years later, was made responsible for the Nonmetals section.

Richard Rollins, secretary of The Atlantic Refining Company, has been elected 1956 national chairman of API's Oil Industry Information Committee. Rollins, who handles his company's public relations, will succeed **W. R. Huber,** public relations director for Gulf Oil Company.

Vice chairman elected to take office with Rollins in December are **Jerry Lubovisky,** with Union Oil Company in Los



FAST, LOW-COST CHANGE IN DIRECTION OF FLOW. Removal of the body cap permits reversing the cage assembly to allow change in direction of flow. In addition, this feature lets you change seat material, and clean the valves thoroughly and quickly — *without removing the valve from the line!*

INTERCHANGEABILITY of seat material to meet your operating requirements is another feature of the Rockwood Top Entry Ball Valve. Seat can be furnished in Buna-N, Neoprene, Kel-F, Teflon, and Nylon.

EASY INSTALLATION AND OPERATION is permitted because of the new handle design. This new design allows the handle to be placed in any of *eight positions!*

Now!... New Rockwood Top Entry Ball Valve

. . . A new concept in valves that saves you money and time!

Made of bronze the new Rockwood Top Entry Ball Valve is ideal for handling oxygen and hazardous liquids as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas and is available both with sweat ends and screw ends, in sizes ½", ¾" and 1".

Write for complete data on this unique full round pipe size flow.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all Principal Industrial Areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
785 Harlow Street
Worcester 5, Mass.

Please send me complete information on Rockwood Top Entry Ball Valves.

Name.....

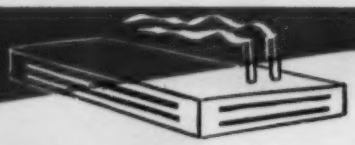
Title.....

Company.....

City.....

Zone....State.....

For more data on advertised products, use Readers' Service Cards, last page.



EVERY INDUSTRY SAYS,
"THIS ONE STEAM TRAP
STANDS OUT!"

CHEMICAL
"Many of our Super-Silvertop Steam Traps have not been touched for 8 years." Los Angeles, Calif.

REFINERY
"Our Super-Silvertops were installed in 1937 and are still rendering satisfactory service after 18 years." Toledo, Ohio.

PLASTIC
"Anderson Super-Silvertop traps in our No. 2 plant are doing a good job . . . with no shutdowns." Chicago, Illinois.

CONTRACTOR
"We consider your traps the best in the industry. We also appreciate very much that Anderson exerts extra effort to assist contractors like ourselves." Spartanburg, S. C.

Only an inverted bucket steam trap with a guided bucket can receive compliments like these. This exclusive Super-Silvertop feature prevents bucket damage, assures years of trouble-free service. Valve and seat are of a special chrome nickel alloy, developed for the corrosion and abrasion conditions in steam lines. Three pipe connections in the head permit Super-Silvertops to be installed straight-in-line or as an elbow with a minimum of piping. It will pay you, as it has hundreds of others, to standardize on Super-Silvertops. FREE—36-page book, "Solving Steam Trap Problems."

The V. D. Anderson Company
Subsidiary of Chesapeake Industries, Inc.

SUPER·SILVERTOP
the Engineered Steam Trap by
ANDERSON

What's Happening. . .

Angeles; **M. S. Hauser**, The Ohio Oil Company, Findlay, Ohio; **G. A. Mabry**, Humble Oil & Refining Company, Houston; **Arthur J. De Blois**, De Blois Oil Company, Pawtucket, R. I., and **Kenneth W. Rugh**, Phillips Petroleum Company, Bartlesville, Okla.

Myers

Marx

George Myers has been appointed superintendent of Ashland Oil & Refining Company's Catlettsburg, Ky., refineries, and **Walker N. Marx** has been made superintendent of the company's refinery at Canton, Ohio. Marx succeeds **William B. Borst**, superintendent at Canton since 1917 and now transferred to the company's headquarters in Ashland, Ky.

Myers has been operating superintendent of the Canton plant since 1952. He joined Ashland Oil as a shift supervisor at Canton and later served as the refinery's maintenance superintendent.

Before 1951, Myers was an engineer with Houdry Process Corporation, and during World War II was a job engineer for E. B. Badger & Son. He also has been with Standard Oil Company of Ohio and Socony Mobil Oil Company.

Marx had been superintendent of the Ashland Oil plant in Catlettsburg since 1952. He joined the company in 1944 as an engineer and later was promoted to shift superintendent and operation superintendent. He previously had been with the Processing department of Lago Oil and Transport Company.

Carl W. Rehfuss has been appointed general manager of Standard Oil Company of California's Richmond, Calif., refinery. He succeeds **R. K. Rowell**, who had been general manager since 1945. Rowell left the post after 38 years with the company.

Rehfuss

Previously assistant general manager of the refinery, Rehfuss has been with Standard since 1924. He has been on the management staff at Richmond since 1940 and also has had experience at the company's El Segundo, Calif., refinery.

Moving up to Rehfuss' former assignment will be **M. F. Miller**, who had been the refinery's manager of operations. Miller, with the company since 1926, will, in turn, be succeeded by **T. M. Sheehy**, who joined Standard in 1937 at the El Segundo refinery.

For more data on advertised products, use Readers' Service Cards, last page.

high quality product

boost average ratings as much as 2 octane numbers with the

Ljungstrom® Air Preheater

With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

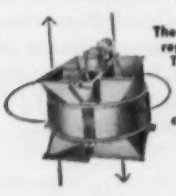
That's why you boost product quality with the Ljungstrom Air Preheater. It's heat-recovery efficiency makes possible advanced furnace designs that assure remarkably close control of processing. And finer control means a more uniform product . . . with average ratings as much as 2 octane numbers higher. One still's added income just from higher product quality is $58 000 annually.

HOW FAST IS "WRITE-OFF"?

In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to *nine months and even less*, when the other Ljungstrom advantages are taken into account — saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment — call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom



The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transfered from the waste gases to the incoming cold air.

The Air Preheater Corporation **60 East 42nd Street, New York 17, N. Y.**

For more data on advertised products, use Readers' Service Cards, last page.

Heard at Meetings . . .

Industrial Relations*

The trend in the industrial relations activities of refineries is a healthy one. The industrial relation group is concerning itself with a wide scope of employe situations. A cross section of these activities along with a broad range of technical papers was given at a recent meeting of the Western Petroleum Refiners Association in Casper, Wyo.

. . . **It is realized** that those who are hired into the refinery working pool, no matter what level the initial entry, may in time work into positions of great responsibility. To reduce the incidence of incompetency at these higher levels, all prospective refinery applications who may become eventual candidates for higher positions are given qualification tests. Although this selection method increases the percent of competent employes in the refinery, it requires a greater pool of applicants from which to choose (George E. Hinckley, Standard Oil Comany (Indiana), Casper, Wyo.).

. . . **The task** of rating and promoting employes is eased through a job evaluation system. The first step consists of making a "job description" of the duties required for each position in order to assess equitable pay. A "job review" is made at regular intervals to assure an up-to-date job description. A "job appraisal" then is made of each individual to determine his proficiency at the job (C. R. McCullough, Phillips Petroleum Company, Bartlesville, Okla.).

. . . **Employes** are given an incentive to improve refinery operations by sharing in the profits of new ideas. A suggestion system is used which pays an employe for new ideas on the basis of the usefulness of the idea to the company. This system places no limit on the amount an individual may be paid (W. S. Wilcox, Socony Mobil Oil Company, Inc., New York).

. . . **Communications** are improved when "Supervisor Conferences and Unit Meetings" are held. About 50 people attend representing positions from the top to the bottom of the refinery organization. The result is a better employe understanding of the refinery policies and philosophies (Ralph W. Klee, Carter Oil Company, Billings, Mont.).

. . . **The latest trends** in instrumentation will relieve the refinery operating personnel of routine data taking duties and will improve product quality through closer control. Electronic selectors and computers will be used for this service (Louis Gess, Minna Minneapolis-Honeywell Regulator Company, Philadelphia, Penn.).

. . . **Many paradoxical** situations have come to light in the relations of fresh water fish to the conditions of the water they live in. Many phenomena have been examined which show that dead fish are not necessarily caused by the waste effluent from a near-by refinery. A systematic study is being made of just which constituents of refinery waste are toxic and which are not (Dr. I. E. Wallen, Oklahoma A & M College, Stillwater, Okla.).

. . . **A new test** has been developed for measuring the oxygen uptake of distillate fuels. The test has very good repeatibility. It is hoped that it will be more widely used in order to establish correlations of the test with other physical and chemical properties of distillate fuels (L. L. Bott and E. T. Ming, National Aluminate Corporation, Chicago, Ill.).

. . . **Close adherence** to the factors of burner design are required to achieve satisfactory service from refinery burners. The advent of reforming is increasing the hydrogen concentration in some refinery streams necessitating the use of specially designed burners for using these streams as fuel (Robert D. Reed, John Zink Company, Tulsa, Okla.).

. . . **Two years** experience has been gained on the operation of the Diesulforming-Catforming combination located at Cody, Wyoming. Many of the variables associated with this hydrodesulfurization and reforming combination have been examined and optimum conditions have been established (J. V. Sheffield and F. B. Odasz, Husky Oil Company, Cody, Wyo.).

*Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Casper, Wyo.

Anti-Knock Action*

Contrary to reports, very fine lead particles suspended in fuel do not show antiknock activity. On the other hand, the breaking apart of the tetraethyl lead compound in gasoline-air mixture just before its combustion may be an important factor in its antiknock mechanism. An equation showed that this decomposition of TEL is related to the temperatures of the end gases in the engine. The end gases are the last gases to burn as the flame sweeps across the cylinders. Although different fuels and additives were tested, none had any direct effect on the rate of the reaction, "but many of them promoted the decomposition of TEL indirectly because they caused heat to be given off, raising the temperature of the gases." The tests were made in a highly instrumented laboratory engine, operated by a separate motor. The engine research technique, together with the equation derived in the research program, are expected to be highly useful both in the further investigation of TEL's antiknock action and in the study of end gas temperatures. The practical difficulties encountered in following the course of chemical reactions occurring in a few thousandths of a second have thus far prevented a clear knowledge of the chemical behavior of TEL in the engine, and the way it surpresses knock. The comprehensive studies under way in the Ethyl laboratories are designed to re-examine the most basic data in the field and to develop information which may shed new light on the antiknock action of TEL. (Dr. Ellis B. Rifkin, Cleveland Walcutt and Dr. Alexander Ross, Ethyl Corporation Research Laboratories.)

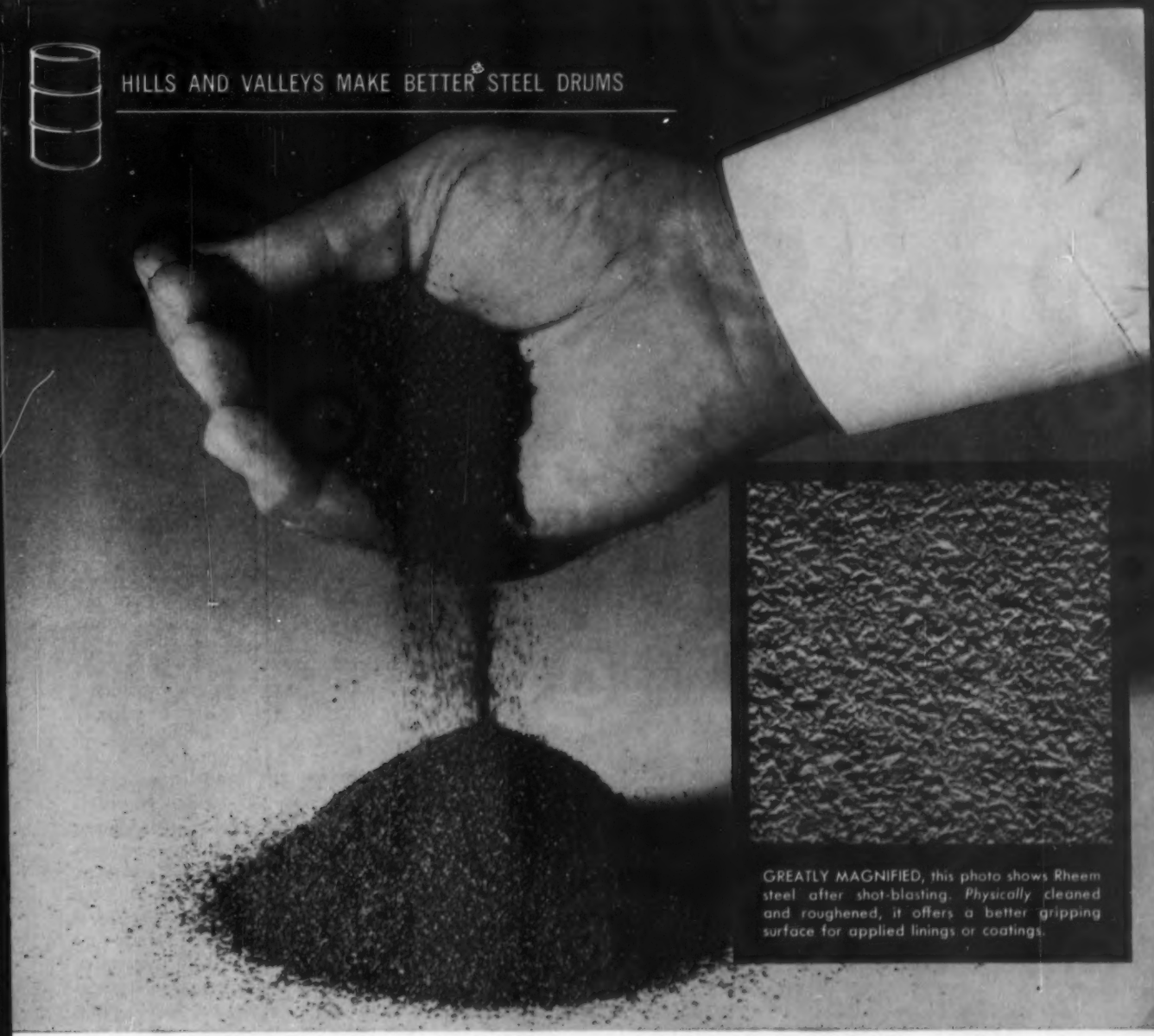
Automation†

The future trend to automatic data handling and data reduction equipment is firmly established. Now, there are some five operating refinery installations of automatic logging equipment, and four are known to be in the planning stage. These data-han-

*American Chemical Society, Minneapolis, Minn., September 15.

†The American Society of Mechanical Engineers (Petroleum Division Conference), New Orleans, September 25.

HILLS AND VALLEYS MAKE BETTER STEEL DRUMS



GREATLY MAGNIFIED, this photo shows Rheem steel after shot-blasting. *Physically* cleaned and roughened, it offers a better gripping surface for applied linings or coatings.

THIS SHOT *is the secret of Rheem's longer lasting steel drums*

Look at the insert above. It shows you the hills and valleys in a piece of shot-blasted steel . . . the steel Rheem uses to give you a better steel drum.

This shot-blasting—the first and most important step in preparing the steel for forming—*physically* cleans and roughens. Millions of carefully sized high-carbon steel pellets bombard both sides of each steel sheet . . . blasting away scale . . . roughening the surface . . . carefully preparing the metal to receive protective linings or exterior coatings.

As a result, when we apply an interior lining or outer coating to a drum, it gets a bulldog grip on scientifically roughened steel. We get a better bond of steel and coating. You get a better drum. Also, because Rheem's shot-blasting gives the steel a "passive" surface, it retards oxidation of *uncoated* sheets.

Next time you place an order for steel containers, remember this: Rheem *physically* cleans its steel by shot-blasting before fabrication. For *any* drum—plain, lined or decorated—that means longer life.

YOU CAN RELY ON Rheem MANUFACTURING COMPANY

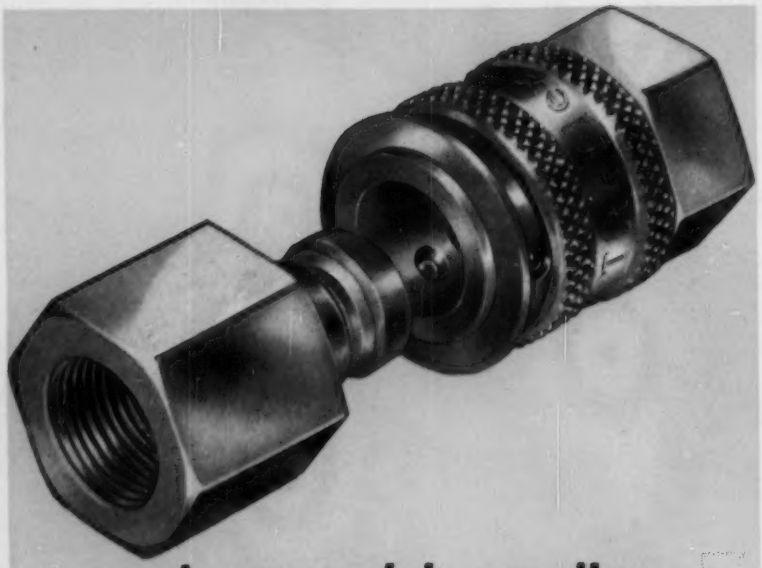
1025 Lockwood Drive, Houston 20, Texas

4901 Jefferson Highway, New Orleans 20, Louisiana

World's Largest Manufacturer of Steel Shipping Containers

RICHMOND AND SOUTH GATE, CALIF., CHICAGO, NEW YORK, LINDEN, N. J. AND SPARROWS POINT, MD.

"It's better to ship in steel"



end your quick coupling problems the QUICK-SEAL way

If you haven't seen the new Titeflex QUICK-SEAL Straight-through and Check-valve Couplings—you have a pleasant surprise coming. These new Couplings . . .

1. Are leakproof. The higher the pressure, the tighter the seal.
2. Couple and uncouple in ONE SECOND—without tools.
3. Prevent hose kinking—through their 360° swivel action.
4. Are slim, easy to handle, not awkward and bulky.
5. Have no projections to snag or bend.
6. Have heat-treated steel bearing surfaces and stainless steel ball bearings and springs for long life.
7. Are made in a variety of alloys and in many sizes up to 12" diameter. Are interchangeable in the same size.

Titeflex QUICK-SEAL Couplings are made in the following types—Straight-through, Single- and Double-Check-valves. The Straight-through type has a smooth bore for free flow without obstructions. ***Write today for Titeflex QUICK-SEAL Coupling Catalog.***

Titeflex, Inc.
Industrial Products Division
600 Hendee Street
Springfield, Mass.

Titeflex
QUICK-SEAL COUPLINGS

I'm interested in the possibilities for your new Quick-Seal Hose Coupling. Send me complete catalog—no obligation of course.

Name_____
Title_____
Firm_____
Address_____
City_____ **Zone**____ **State**_____

The HIGHER the Pressure the TIGHTER the Seal

Who's Meeting . . .

dling machines not only print the hourly log sheet in a matter of minutes, but may be equipped with scanning mechanism to watch over critical points between logging periods.

An off-normal point will sound an alarm and may be printed on the log sheet or on a separate typewriter. With a little additional equipment, the machine also can manipulate process quantities into usable accounting data and transmit this information to a remotely located accounting division. Furthermore, it can reproduce the data in some directly usable form, such as a ledger, or punched card.

With this equipment, we have a new tool of tremendous future importance. What will this mechanism accomplish for us? It will give us infinitely more accurate data. (1) Because human error and intentional falsification will be eliminated. (2) The data at the beginning and the end of the log period will be in phase, whereas present manual logging may be from 0 to 180 deg out of phase.

We will obtain data not previously obtainable by the human element in the chain. The value of log sheets, as taken today, is questionable. Suppose we are taking the hourly log for a gas-concentration unit. If we are fortunate to be logging the depropanizer at the instant an upset commences in that unit, we will have a rare piece of data.

On the other hand, if the upset occurs at some column downstream of the depropanizer at the logging time, its origin may be difficult or even impossible to determine. Upsets may occur and be controlled between log periods and never show on the log sheet because of this out-of-phase condition in our present methods. With data-handling equipment, plant upsets can be watched as they originate and progress through the entire chain of processes.

Improving equipment is a continuing trend. It follows many blind alleys and is guilty of being side-tracked by fads. To be consistent with our goal of an automatic plant, existing methods and equipment must be improved. Improved process efficiency demands improved control circuits. One of the factors in reducing off spec and rerun

time is the control-circuit response time. Plants are becoming physically larger. To comply with these demands, we have an established trend away from pneumatic controls, with their physical limitations, to electronic mechanisms with instantaneous electronic transmission of data.

This trend has important relationships with the other trends of automatic data-handling, continuous stream analysis and computer control. Fundamentally, all of these new developments are electronic devices and for a satisfactory marriage of all of them at some future time it is essential that they be compatible. As is naturally the case with new developments, we have tools available before we are capable of using them fully, or comprehending their full advantages. When we gain experience with these two new tools, data-handling equipment and continuous stream analyzers, the benefits to be gained from a computer type master controller will become more evident. (G. G. Gallagher and R. A. Robinson, The Fluor Corporation, Los Angeles.)

Competition*

It is natural, and not entirely unhealthy, that each of us should regard his own business as the most important in the country. It is also natural (in the sense that all human frailties are natural) but decidedly unhealthy to want to buy in a low, open market and to sell in a high, closed market.

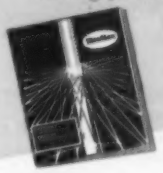
If any of us in the oil business are to be protected against competition by law, we must expect soon to find that we have to buy our food, clothes, automobiles, radios and all the other goods we want and need from businesses similarly protected against competition. I am sure that even those service station dealers who are seeking legislative relief against the vicissitudes of the free market would be among the first to oppose any measure to protect all their personal and business suppliers from competition. (B. Brewster Jennings, chairman, Socony Mobil Oil Company, Inc.)

*National Petroleum Association, Atlantic City, September 14.

...to handle vibration, temperature and corrosion headaches in conveying applications

Do you have to conduct water, solutions, fuel, lubricants, oxygen or other gases or liquids between two points which may not remain fixed? Your answer is Titeflex flexible metal hose.

Titeflex offers you just about everything you could wish for in metal hose—seamed or seamless, braided or unbraided, a wide choice of alloys and fittings. And Titeflex has the originality and experience to simplify your design difficulties—the laboratory control and development engineering assistance you want behind you. All you have to do is send your drawing; we fill in the exact hose type required. ***Telephone or mail in the coupon for full information about metal hose and its uses, catalog #200.***



Titeflex

FLEXIBLE METAL HOSE

TITEFLEX, INC.
Industrial Products Division
600 Hendee Street
Springfield, Mass.

Your knowledge of metal hose applications may be helpful to us. Please send your complete catalog—without obligation.

Name_____

Title_____

Firm_____

Address_____

City_____ **Zone**_____ **State**_____

For more data on advertised products, use Readers' Service Cards, last page.

Known by the company they keep

Imperial Oil, Sarnia, Canada
Standard Oil of B.C. Vancouver, British Columbia
Esso Standard Oil Co., Everett, Mass.
Esso Standard, Antwerp, Belgium
Imperial Oil, Ioco, Canada
Peabody Air Heaters
Imperial Oil, Regina, Canada
Standard-Vacuum, Durban, South Africa
Esso A. G., Hamburg, Germany
Caltex, Batangas, Philippines
Kurnell (Caltex), Australia
Emp. Colombiana, Colombia, South America
Yokohama (Nippon Petroleum Refining Co., Ltd.), Japan

Air Heater Bulletin No. 600-A illustrating this and other applications is available on request.

THROUGHOUT the world Peabody Direct Fired Air Heaters are used wherever dependability of performance is essential. As examples, we point with pardonable pride to Peabody Installations on patented Esso Research and Engineering Company's Model IV Cat. Crackers, which are available under license to the industry. For this service the Peabody Air Heater is readily incorporated into the base of the regenerator.

The Peabody design utilizes a positively air-cooled furnace with a portion of the air to be heated by-passed around the refractory-lined combustion chamber. This important feature makes for high combustion efficiency in a compact piece of equipment.

PEABODY ENGINEERING CORPORATION

580 FIFTH AVENUE, NEW YORK 36, N. Y.

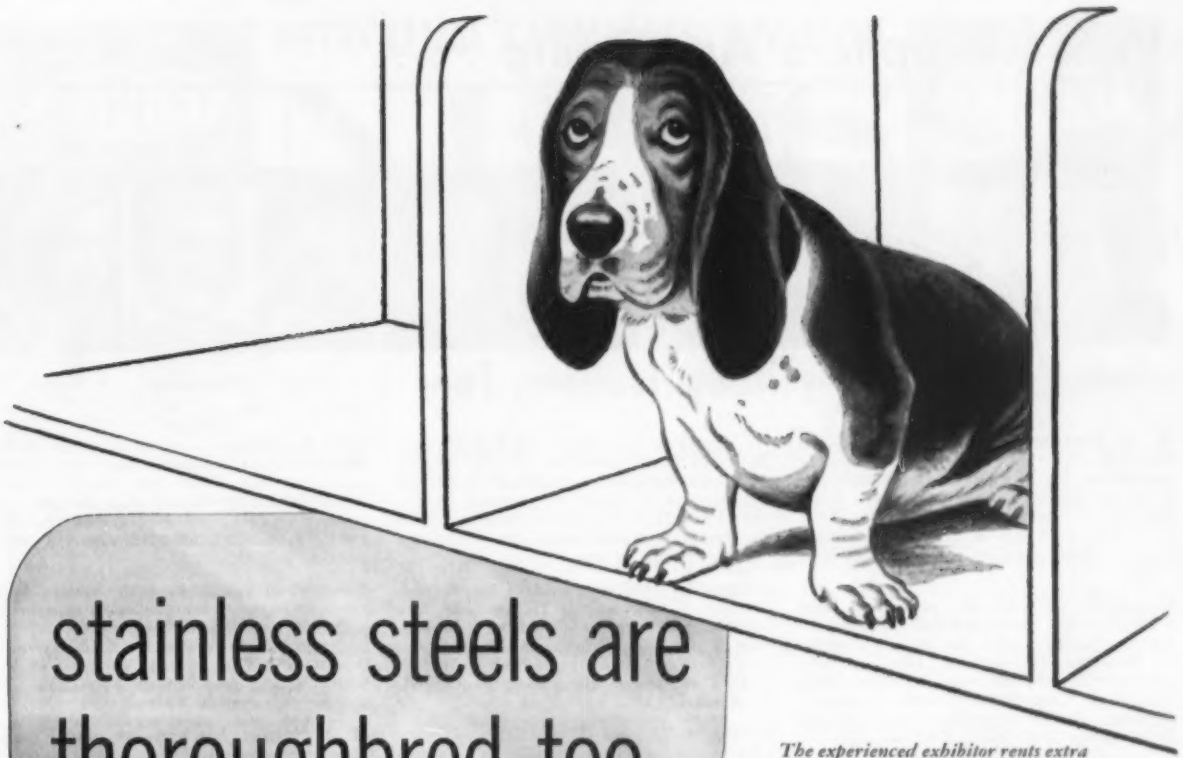
OFFICES IN PRINCIPAL CITIES

B-090 *PEABODY LIMITED • LONDON, S.W. 1, ENGLAND*

MEETINGS CALENDAR

OCT. 11–15	Society of Automotive Engineers, Statler Hotel, Los Angeles, Calif.
12–14	National Association of Corrosion Engineers, Permian Basin Section, (Biennial Permian Basin Corrosion Tour), Headquarters at Lincoln Hotel, Odessa, Texas.
13–14	California Natural Gasoline Association (Annual Fall Meeting), Ambassador Hotel, Los Angeles.
14	American Institute of Chemical Engineers, South Texas Section, (Annual Technical Meeting), Galvez Hotel, Galveston, Texas.
17–19	American Gas Association (Annual Convention), Los Angeles.
18–20	American Institute of Electrical Engineers (Motor Applications and Problems in Heating and Cooling Conference), St. Louis.
18–21	National Association of Corrosion Engineers (South Central Regional Meeting), Shamrock-Hilton Hotel, Houston.
18–22	National Safety Council (National Safety Congress and Exposition), Chicago.
18–22	National Safety Congress & Exposition, Sponsored by National Safety Council. Chicago.
20	American Institute of Chemical Engineers, New York Section, Hotel Statler, New York.
20–21	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting, Garrett Hotel, El Dorado, Ark.
24–26	American Standards Association (Annual Meeting), Sheraton Park Hotel, Washington, D.C.
24–28	American Society of Civil Engineers (Annual Convention), Statler Hotel, New York.
25	Association of Consulting Chemists and Chemical Engineers (Annual Meeting), Belmont Plaza Hotel, New York.
27–29	Rocky Mountain Oil & Gas Association (Annual Convention), Cosmopolitan Hotel, Denver, Colo.
28	Natural Gasoline Association of America (Southern Regional Meeting), Captain Shreve Hotel, Shreveport, Louisiana.
31–Nov. 2	Society of Automotive Engineers (Transportation Meeting), Chase Hotel, St. Louis, Mo.
31–Nov. 2	National Lubricating Grease Institute (Annual Meeting), Edgewater Beach Hotel, Chicago.
NOV. 2– 4	Society of Automotive Engineers (Fuels and Lubricants Meeting), Bellevue-Stratford Hotel, Philadelphia.
3– 4	Annual Instrumentation Conference, Sponsored by School of Engineering, Louisiana Polytechnic Institute, Ruston, La.
13–18	Society of Mechanical Engineers, (75th Anniversary Meeting), Blackstone and Hilton Hotels, Chicago.
14–15	Commercial Chemical Development Association and Chemical Market Research Association (Joint Meeting), Carter Hotel, Cleveland.
14–17	American Petroleum Institute (Annual Meeting), Mark Hopkins, Fairmont, St. Francis and Palace Hotels, San Francisco.
14–18	Chicago Exposition of Power and Mechanical Engineering, Sponsored by The American Society of Mechanical Engineers, Chicago Coliseum, Chicago.
15–16	American Petroleum Institute (Board of Directors Meeting), Mark Hopkins Hotel, San Francisco.
16	Oil Industry Information Committee (Steering Committee Meeting), St. Francis Hotel, San Francisco.
16	American Petroleum Institute (Executive Committee Meeting), Mark Hopkins Hotel, San Francisco.
18–22	National Safety Council and National Safety Congress and Exposition, Chicago.
20	National Petroleum Council, South Interior Building, Washington.
20–21	Western Petroleum Refiners Association (Regional Meeting and Industrial Relations Meeting), Garrett Hotel, El Dorado, Ark.
27–30	American Institute of Chemical Engineers (Annual Meeting), Statler Hotel, Detroit.

For more data on advertised products, use Readers' Service Cards, last page.



stainless steels are thoroughbred, too

The experienced exhibitor rents extra stalls... leaves them empty... to prevent contamination of his thoroughbred pets by canine neighbors.

To develop their best qualities demands *exclusive* care. That is why Sun Ship's new Alloy Products Shop has been planned for the *exclusive* fabrication of stainless and alloy steel products. When you have selected from the many available Alloys a stainless steel best suited for your service condition, you have done only half the job. You must also provide for the best possible fabrication if you are to have full protection—"A Thoroughbred Job."

Why entrust stainless steel to be fabricated in the same shop where carbon steel products are fabricated, and subject this precious metal to contamination with iron fragments, dust, or other harmful elements? A segregated shop is your answer.

Sun Ship now operates an all-alloy shop, one especially built and equipped for fabricating stainless and alloy products as they should be—segregated from carbon steel fabrication.

We emphasize the fabrication of medium and heavy stainless, alloy and aluminum products for industry.

Try Sun Ship for stainless fabrication as it should be done.

Our Sales Engineering Department will be pleased to assist you with any of your fabrication problems.

Sun Ship also makes all types of carbon steel pressure vessels.

ALLOY PRODUCTS SHOP

OF Sun SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • **CHESTER, PA.** • 25 BROADWAY, NEW YORK CITY

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Boucher | Clifford | Wagenhals | Fee | Wallace | Muller | Curran | Kominek | Buttner

H. G. Boucher, formerly with Shell Oil Company, has been named sales engineer in **Arthur G. McGee & Company's** Petroleum division. Boucher, who will headquarter in New York, left Shell in 1954 to join C. F. Braun & Company as a district engineer handling sales work in New York.

George F. Clifford, Jr., previously sales manager for International Equipment Company, has joined the Spinco division of **Beckman Instruments, Inc.**, as sales manager. He also has been associated with Pittsburgh Consolidation Coal Company, General Radio Company and Crosby Steam Gage and Valve Company.

Robert E. Wagenhals, since 1946 director of quality control for **The Timken Roller Bearing Company**, is manager of a new Sales Forecast department set up to make long-term forecasts of sales activities.

C. Allan Fee, secretary of **ACF Industries, Inc.**, has been moved up to take on the additional duties of vice president. He will continue as secretary, a position he has held since 1950. Fee has been attached to the secretary's office since he joined the company when he was 15 years old.

George M. Wallace, head of George M. Wallace & Company in Denver, has been selected to represent **Cochrane Corporation** in the Rocky Mountain district. Wallace's firm operates a branch office in Salt Lake City, under the management of **R. E. Kunkel.**

F. W. Muller has been appointed manager of **Gustin-Bacon Manufacturing Company's** Insulation Sales department. Also receiving new appointments in the department are **H. M. Grant** named assistant manager, and **S. E. Brelsford**, assigned as assistant to the manager.

John R. Curran, director of engineer for **Hammel-Dahl Company**, has been elected vice president. With the company since 1945, Curran served first as a process engineer, moving up to chief design engineer in 1949, and appointed director of engineering in 1953.

Edward G. Kominek, with **Infilco, Inc.**, since 1937, has been promoted to general sales manager. He will supervise company representatives in the U. S. and other country's, including those assigned to Infilco Canada and Infilco Mexicana. He will headquarter in Tucson, Ariz.

H. J. Buttner has been appointed manager of engineering for Le Roi Division of **Westinghouse Air Brake Company.** He has held engineering management positions with Continental Motor Corporation, Allison Division of General Motors and Packard Motor Car Company.

Stone | Avery | Hardy | Haslanger | Carroll | Arthur | Bailey | Moore | Bootes

Earl N. Stone has been appointed sales engineer for **Edward Valves, Inc.**, in Colorado, Utah, western Kansas, Montana and Wyoming, as well as Farmington, N. M. He previously was a sales engineer in Denver for Orbit Valve Company.

Julian M. Avery has been named director of **Ethyl Corporation's** Product Development division, succeeding **William T. Hack**, who resigned. Avery, who had been an Ethyl consultant, joined the company as a technical adviser in September 1952. He will retain these duties in addition to his new responsibilities.

Warren L. Hardy, in the Business Analysis and Research department of **Norton Company** for the past year, has been appointed business research manager. He succeeds **Myron N. Smith**, who retired after 40 years with the company. Hardy formerly worked as a member of the company's sales engineering staff.

Robert U. Haglanger is the new director of industrial sales for **Stauffer Chemical Company.** Haglanger, who will continue to headquarter in New York, had been Eastern sales manager. He succeeds **T. A. Maschke**, who died recently.

David R. Carroll, formerly with Humble Pipe Line Company, has joined **Maintenance Engineering Corporation** as a district sales engineer. He will office in Shreveport, La., and handle the company's sales and service operations in Arkansas, Louisiana and East Texas.

J. B. Arthur, president and founder of **Mexico Refractories Company**, was honored on the manufacturing company's recent 25th anniversary. A bronze plaque commemorating his leadership was presented to Arthur by 16 men who have been with him since the firm was organized

Alfred W. Bailey, associated with equipment sales since 1926, has been made manager of an office opened recently in New York by **Kieley and Mueller, Inc.** The new sales office represents a departure from the company's usual practice of representation by independent sales agencies. Bailey will be assisted by **John P. Healy**, with the company five years.

William A. Moore, district representative for **U. S. Steel Corporation's** Oil Well Supply division in Huntington Beach, Calif., has been transferred to Long Beach. Moore, with the company since 1947, has served as district representative at Avenal, Taft and Ventura, Calif. He started with the company as a storeman at Avenal.

Henry V. Bootes, vice president of **ACF Industries, Inc.**, has been made a member of the corporation's Operating committee and head of its Marketing department. He also will serve as chairman of the Marketing committee which reviews and makes recommendations on proposals for new plants, products and changes in product lines.

The Ethyl Corporation has awarded 19 graduate research fellowships in the fields of chemistry, chemical engineering and mechanical engineering for the 1955-56 school year. The value of the awards

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

October ★ One of a Series of Interest to the Petroleum Industry ★ 1955

A symbol of SERVICE in every community

To the American motorist, the words "petroleum products" and "service" have become almost synonymous.

But the typical American service station stands for more than just automotive service. It stands for *service to the community*, too . . . because the man who operates the station is a *good neighbor*, the kind of man you can count on to take an active part in civic, church and club affairs. And behind the service stations are the thousands of oil company employees and distributors who work together – not just during Oil Progress Week – but 52 weeks a year to make oil progress an important part of the over-all progress of our whole American community.

A PORTRAIT OF PROGRESS

"Speak to the Earth" is a book about oil and oil people

"A new and refreshing book about oil . . . the growth of a great industry in terms of human endeavor and almost super-human achievement!"

We think you'll agree with this statement, too, after you have read "Speak to the Earth," the new book covering the oil industry by Max Miller, well-known author of "I Cover the Waterfront" and 22 other books. The book explains exploration, drilling, production, transportation, refining and marketing, in an easy-going, realistic, yet entertaining style.

Max Miller was retained by the Du Pont Company to write the story. And to help promote a better understanding of the oil industry, the book is now being made available to the public at book stores by its publisher, Appleton-Century-Crofts, Inc.

New survey studies dealer knowledge of product quality and sales assets

That old familiar phrase, "know your product," is still a cardinal rule of good selling. And since your service station dealers are your main link with the motoring public, their knowledge of your product features can have a mighty important bearing on your own sales volume.

But how much does the average service station dealer really know about the products he sells? To help you answer this question accurately and statistically, Report No. 2 of the new Du Pont survey on "The Service Station Operator" is now ready for distribution to oil company marketing executives. Here is a quick preview of the type of information it contains.

HOW MUCH do dealers know about the additives in the gasolines they sell? This new Du Pont survey can help you answer this question.

The report discusses the dealer's knowledge of the products he sells, including his knowledge of additives and their functions, his opinion of what his greatest gasoline sales assets are, and his knowledge of gasoline pricing.

"What's the difference?"

Our researchers asked this question in regard to the difference between "regular" and "premium" grades. Two-thirds of the dealers mentioned *octane number* as the chief difference. And many of them answered in terms of customer benefits – such as power and pick-up, antiknock, starting and warm-up qualities, and mileage.

But what about brand differences? The dealers' answers to this question may be quite significant—although not as encouraging. Nearly two-thirds of the dealers said they felt the premium gasolines sold by the major oil companies were pretty much the same . . . and more than two-thirds felt that the regular gasolines were pretty much the same, too. But of those who felt there was a difference, two-thirds said their own brand was superior.

The survey also documents the dealers' knowledge of motor oil quality. In this respect it is interesting to note that,

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED *Dealer Survey*

when discussing the difference between grades of oil, more than half of the dealers mentioned the *detergency* of the oil.

Other factors

The dealers' knowledge of the additive content of the petroleum products they sell was also probed . . . as was their knowledge of prices in their local marketing area. And the survey included questions about tires, batteries and such services as chassis lubrication and automatic transmission service.

Their own sales assets

To the question, "What do you consider your greatest sales asset?" the dealers returned a wide variety of answers. You'll probably find this page the most interesting and significant in the whole report. It includes the dealers' own relative ratings of such factors as brand, station location and hours, advertising, service, friendship, and many more.

Regional breakdowns

Although the dealer survey is nationwide in scope, it is broken down regionally according to the four main marketing areas of the country. Because of this, it will be extremely helpful to regional as well as national marketers.

Sponsored by Du Pont, the survey was conducted by National Analysts, Inc., on a completely impartial basis. The results are being published in a series of five reports. The first covers station hours and rush periods, gallonage sold, customer credit, and the use of customer mailing lists.

Now available

Both Reports No. 1 and 2 are now available to marketing executives through any of our regional offices listed below. The remaining three reports will be issued periodically during the next six months.

Continuing market research

This survey on "The Service Station Operator" is part of the continuing market research work of the Du Pont Petroleum Chemicals Division. Another part of this program is the Du Pont survey of service station customer buying habits.

CENTRAL REGION LAB MANAGER

ARTHUR R. KERNEN joined the Du Pont Company in 1947 after receiving his M.S. degree in chemistry at the University of Delaware.

His first assignment was as a research chemist at the Du Pont Petroleum Laboratory. Following this he did both development and sales-service work on gasoline additives and stability problems.

In September, 1953 he was appointed manager of the Petroleum Chemicals Division's Central Region laboratory in Chicago. He is in charge of customer service in product testing and analysis and additives treating recommendations.

Before beginning his graduate work, he received a B.S. degree at the University of Notre Dame. He also attended Xavier University in Cincinnati, Ohio.

ARTHUR R. KERNEN

Mr. Kernen is a member of the Society of Automotive Engineers and the American Chemical Society.

Du Pont's Fuel-Injection Test Car Hits the Road

In view of the possibility that many automobiles will soon be equipped with fuel-injection engines, a special fuel-injection system was added to a Lincoln car at the Du Pont Petroleum Laboratory in 1954. The purpose of this car is to study the possible advantages of fuel injection to the refining industry.

From testing a variety of gasoline blends in the fuel-injection engine, it has been found that fuel-injection permits greater flexibility in blending fuels. Higher vapor pressures can be used, and it is possible that increases in end point might be practical. These wider tolerances could mean a substantial benefit to refiners and the motoring public.

The car has a standard Lincoln V-8 engine to which has been added an American Bosch fuel-injection system and special instrumentation. The system gives freedom from carburetor icing, relief from vapor lock troubles, improved power, and permits styling changes since the hood lines can be lowered with the less bulky fuel-injection pump.

For studying the performance of different gasolines in the fuel-injection engine, the Petroleum Laboratory has tested the car on the laboratory's chassis dynamometer. The Petroleum Chemicals Division has also made plans for the car to make a demonstration tour.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—P. O. Box 730 . . . . . Phone LUther 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . Phone CApitol 5-1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond Street West, Toronto 1, Ontario
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Del.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

Printed in U. S. A.

Suppliers . . .

ran to a total of about $45,000. Each fellowship provides the recipient with $1500 for living expenses plus an allowance for tuition and fees. In addition, the college department receives $500 for expenses in connection with the fellow's research work.

Blasingame Price Mullarkey

Oakite Products, Inc., has appointed three new Technical Service representatives. They are **Charles L. Blasingame,** for six years a salesman for a paper firm, now servicing Oakite accounts in Dayton, Ohio; **John A. Price,** a University of Dayton graduate, assigned to service accounts in the West Chicago area, and **John C. Mullarkey,** formerly a contractor in Los Angeles, assigned to the Phoenix, Ariz., territory.

ALCO Products, Inc., has named **Douglas B. Fraser** manager of its recently-acquired Cincinnati plant. With the company since 1939, Fraser has held posts as estimate analyst, supervisor of engineering changes, price-analysis supervisor and facilities committee supervisor.

Stauffer Chemical Company has appointed **P. S. Brallier** as technical advisor to the president. Brallier, with the company almost 40 years, was director of market research and development. He will be replaced by **A. N. Wohlwend,** moved up from sales development manager.

The Fluor Corporation has appointed Hixson & Jorgensen, Inc., a Los Angeles firm to handle its advertising and sales promotion.

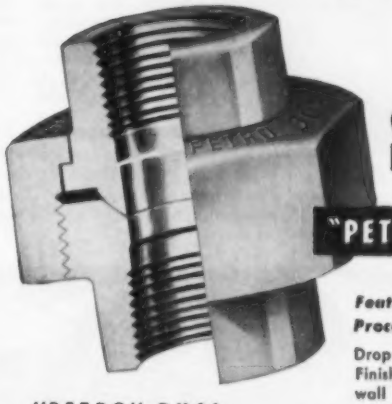
General Electric Company has named **George L. Irvin,** a commercial vice president headquartered in Dallas, to succeed **Ross I. Parker** as resident company officer for a ten-state Midwest area. Parker, a commercial vice president in Chicago, has retired after 43 years with the company.

Laclede-Christy Company, Division of H. K. Porter Company, Inc., has made **Kenneth S. Patton** its sales representative in an area comprising Oklahoma, north Texas, west Arkansas and south Kansas. Patton, to be headquartered in Oklahoma City, previously was with Mexico Refractories Company for ten years.

Leeds & Northrup Company has advanced **William L. Kimber,** since 1940 a sales engineer in its Buffalo, N. Y., office to manager of that district. He replaces **Joseph M. Jackson,** who was appointed manager of the district sales office in Philadelphia.

Other changes in the personnel of its field sales organization include the pro-

again MARK is FIRST
with America's Finest
STAINLESS
STEEL UNIONS



"PETRO" 304-316

"PETRO" DUAL

These unions are made with stainless steel ends and carbon steel nuts. Nut threads are permanently lubricated for easy make and break.

Feature Packed for Multiple Service on All Processing Where Stainless Steel Is Required

Drop forged from uniformly heated solid bars. . . . Finished to American Standard A.A.R. . . . Uniform wall thickness and concentricity maintained through quality controlled production. . . . Precision machined seats plus a differential in hardness form a perfect seal and will not seize at high temperatures. . . . Octagon shaped ends and nut provide safety from and resistance to distortion by wrench abuse.

A NEW CATALOG COMPLETELY DESCRIBES ALL OUR UNIONS . . . WRITE TODAY!

Clayton Mark & Company
1900 DEMPSTER STREET EVANSTON, ILLINOIS U.S.A.

For High Temperature-High Pressure Sealing

DURA SEAL TYPE P.T. is the engineered mechanical seal for meeting severe sealing conditions. Pressures from 50 psi to 1000 psi . . . temperatures from minus 80°F. to 450°F. For sealing all fluids except molten alkali metals and some fluorine compounds in the higher temperatures. For information on applications . . .

Write today for Dura Seal Catalog No. 455-PF

DURAMETALLIC CORPORATION, Kalamazoo, Michigan

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

motion of **W. Spencer Bloor**, sales engineer in the Chicago office since 1946, to district manager at Atlanta, Ga. He succeeds **William A. Macan, III**, who was appointed manager of the Cleveland district office.

The Timken Roller Bearing Company has made two new appointments in its Research and Development division. **John Rundt**, with the company since 1935, was named chief engineer, and **Alvan Kopatz**, who started with Timken in 1940, was made chief draftsman.

Clark Equipment Company will establish a West Coast plant before the end of the year. The new facility will be used as a parts depot at the outset and later will be expanded as an assembly plant. It will be located in the San Francisco Bay area.

The Foxboro Company has appointed **R. E. Rogers** manager of its West Coast sales activities. Rogers has headed the company's Los Angeles office since 1946, and formerly served as an industrial engineer in the Tulsa and New York offices. He will make his headquarters at the new Foxboro plant in San Leandro, Calif.

Alan Wood Steel Company has appointed **J. Bremner Proctor** as general manager of its new Penco Metal Products division. He has been associated with the metal shelving equipment field for the past 12 years.

Ethyl Corporation has advanced **Hudson W. Kellogg**, assistant manager of the Gasoline Testing division since 1946, to division manager. He replaces **J. Clifford Pope**, who died recently.

Kellogg

Kellogg joined the company at its Yonkers, N. Y., laboratory in 1929 and a year later was made manager of the testing laboratory in Detroit. He returned to Yonkers in 1938 as manager of the laboratory, and in 1941 was appointed coordinator of all Ethyl gasoline testing laboratories.

Rockwell Manufacturing Company has named **George L. Geuss** as its resident manager in Venezuela. He will be stationed in Caracas. Formerly assistant product manager for the company's Meter & Valve division, Geuss joined Rockwell in 1940 as a service engineer in the Buffalo, N. Y., area where he served until 1946. From 1946 to 1954 he served in the New York area.

Haynes Stellite Company, a division of Union Carbide and Carbon Corporation, has named **Frederick C. Kroft** as general superintendent of manufacturing. Kroft, who joined the company in 1936, was superintendent of the Inspection, Process and Quality Control department prior to his new promotion.

Harbison-Walker Refractories Company has promoted **Frank P. Shonkwiler** to manager of its basic sales organization. He formerly was a member of the sales staff in the company's Chicago district. He will be transferred to Pittsburgh.

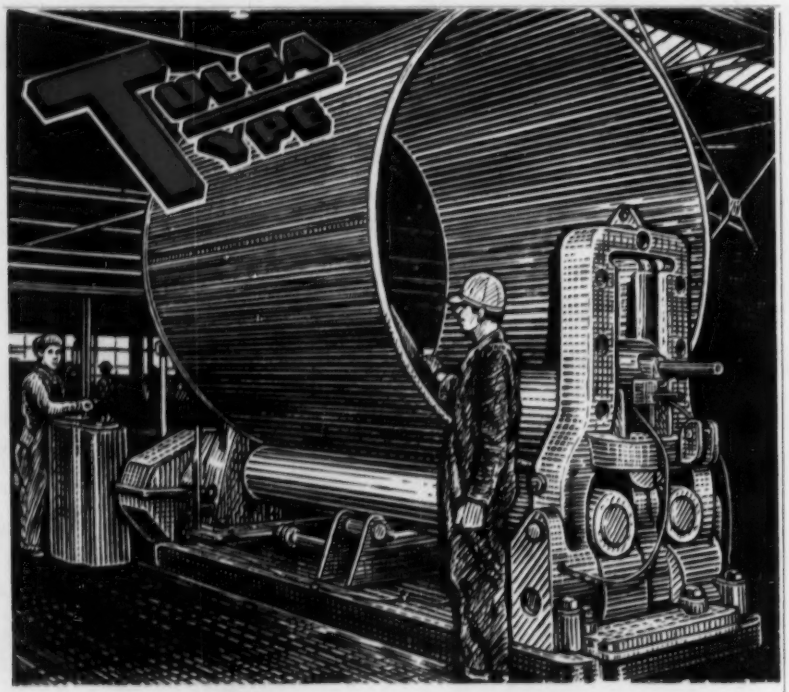
Graver Construction Company, Inc., has appointed two district construction managers. For the Midwest area, **Martin H. Swanson** has taken charge of the district office at Joliet, Ill., and in the East, **Frank D. Ahern** heads a new district construction base at Wilmington, Del.

Carbide and Carbon Chemical Company has approved an expansion program for its plant at South Charleston, W. Va., and construction is scheduled to start immediately. The project will increase the plant's capacity by about 35 percent. The increased production is expected to come in during February 1956.

Blaw-Knox Company has formed a new foreign affiliate, Blaw-Knox de Venezuela, C. A. The new affiliate is jointly owned by Blaw-Knox and Venezuelan interests. Purpose of the organization is to engage in engineering and construction work in the South American country.

Graver Tank & Mfg. Company, Inc., has been granted an access permit by the U. S. Atomic Energy Commission. This permit applies to all Graver divisions, including Graver Water Conditioning Company and to the subsidiary Graver Construction Company, Inc.

Permits of this sort are now being made to certain accredited and selected fabricators under new AEC regulations. This



WE ROLL OUR OWN AT FLINT

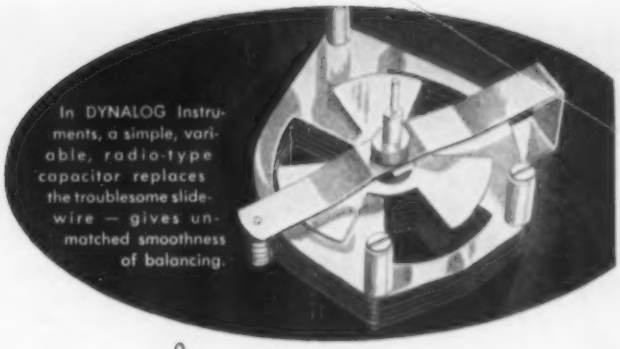
It takes the right equipment and plenty of know-how, to roll steel plate up to 2" thick, as smoothly and as accurately as you'd roll a cigarette. Here at FLINT STEEL, we have both the tools and the experience. In our fabricating shop, plates of heavy steel are cut, rolled, bent, shaped and welded with the precision necessary to satisfy the exacting specifications of the oil industry. We invite you to call on us for any steel plate fabricating problem—from small tanks to giant towers.

Write for our General Catalog

BUILT Right

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.



In DYNALOG Instruments, a simple, variable, radio-type capacitor replaces the troublesome slidewire — gives unmatched smoothness of balancing.

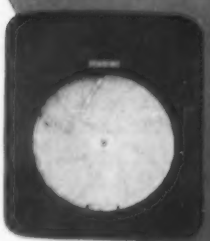
This potentiometer has no slidewire

STEPLESS CAPACITY-BALANCING

ELIMINATES SLIDEWIRE MAINTENANCE

DYNALOG'S* EXCLUSIVE BALANCING ACTION

- no slidewire
- no batteries
- no standardizing
- no gears, cables, etc.
- no high-speed reversing motor



There's no need to put up with worn slidewires and sticking electrical contacts . . . no need to periodically clean and lubricate balancing motors. DYNALOG design eliminates all this! Its simple variable capacitor and positive magnetic drive provide *continuous, stepless* balancing . . . *never* require attention!

DYNALOG's friction-free action provides high speed of response without wear. (There are only five moving parts, including the recording pen!) Sensitivity, unlimited by turns of slidewire winding, is 1/100 of 1%. And accuracy is a sustained 1/4 of 1%.

DYNALOG Instruments are available for use with resistance, voltage, capacity, or inductive type primary elements to measure and/or control any process variable . . . with unmatched smoothness. Write for Bulletin 427. The Foxboro Company, 7410 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U.S. Pat. Off.

FOXBORO

*Reg. U.S. Pat. Off.

DYNALOG

ELECTRONIC INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

will permit industrial suppliers to cooperate more fully with the AEC in the development of materials, designs and manufacturing technology. The granting of such permits will further the present program to utilize atomic power for peaceful purposes.

Hammel-Dahl Company has opened a new sales office in Tulsa, Okla. The office will be under the supervision of *Paul E. Bowles*, formerly with Black, Sivalls & Bryson. Bowles was named district sales manager.

New Houston Facility Complete—

Daniel Orifice Fitting Company has completed its new facilities in Houston. The site covers 15 acres. New installations, including sales and executive offices, a fabricating plant, machine shop and warehouse, take up more than 26,000 square feet. The new plant and sales offices are managed by W. A. Griffin, vice president and general manager.

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve your malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FLUIDS	MINERAL SPIRITS	WAXES	NAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BQM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 230 Park Avenue, New York 17, N. Y.

Rhodia INC.

A. W. Cash Company has three new agents for its line of equipment. Two Cash-Standard agents have changed their firm names. The new agents are I. W. Cotton Company in Indianapolis, covering central and southern Indiana; Fuel Economy Enginering Company, St. Paul, assigned Minnesota, North and South Dakota and northwest Wisconsin, and Keener Sales Company, Knoxville, covering eastern Tennessee.

Names changes include Quinn, McKerall & Quinn Company, Birmingham, Ala., formerly McKerall Engineering Company, and Whitlock Manufacturing Company, Chicago, formerly Reitz & Weeks Company.

Laclede-Christy Company Division, H. K. Porter Company, Inc., has made **Andrew M. Coventry** its credit manager. He will supervise accounts receivable, credits, collections and credit policies and procedures. He previously was credit manager for Magic Chef, Inc.

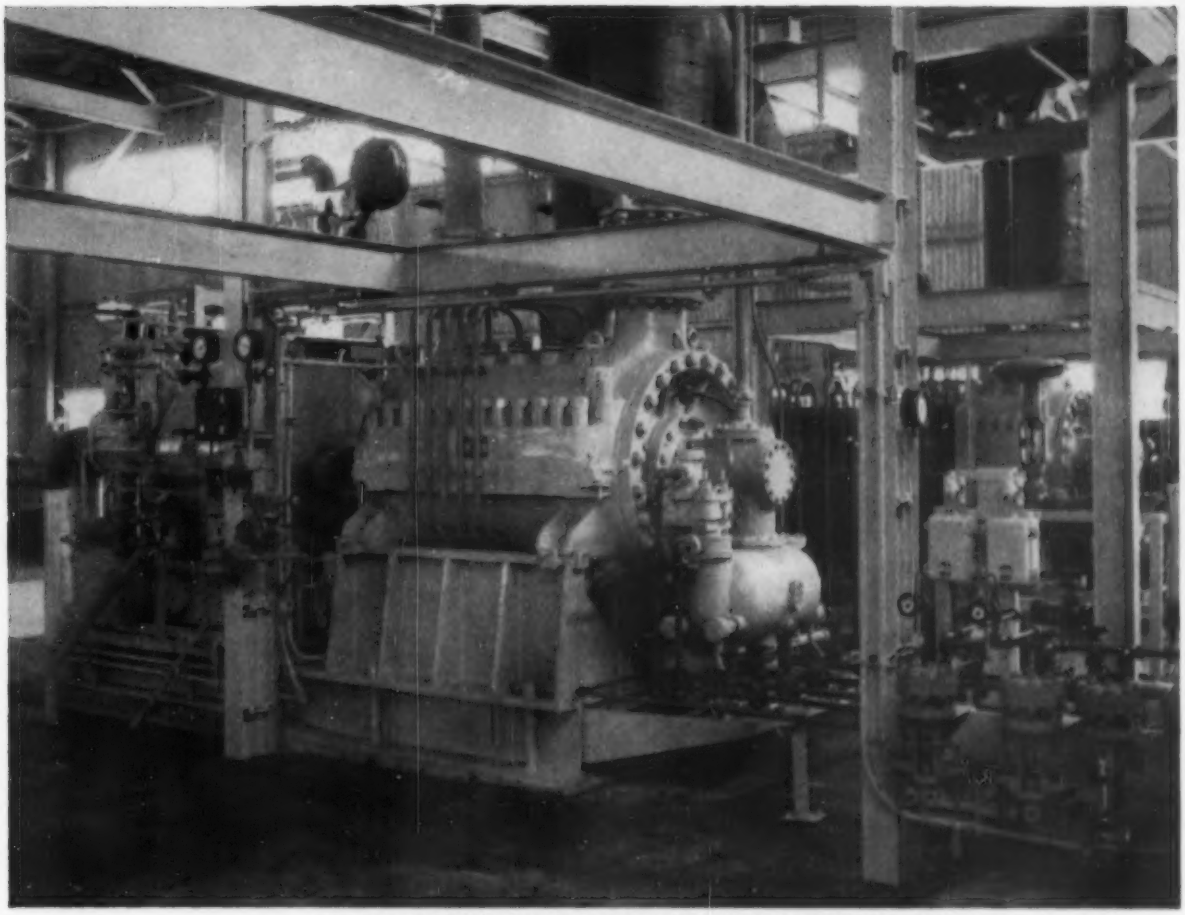
Selas Corporation of America has transferred **William M. Smith** from the New York-northern New Jersey area, where he was sales representative, to the home office, to coordinate sales and sales-engineering activities and handle special assignments.

Smith will be succeeded in his old territory by **William C. Schneider,** transferred from the Rochester, N. Y., area. He, in turn, will be replaced by **Kenneth E. Rasmussen,** formerly with the company's Sales Engineering department.

R. P. Adams Company, Inc., has **James Bush, Jr.,** as its representative in New England. He headquarters in Framingham, Mass. Bush formerly was with L. Lawrence Company, Inc., as an assistant to the president and before that served as a sales engineer with Kewanee-Ross Corporation.

Metrotype Corporation will move from Summit, Ill., to a new building under construction in Michigan City, Ind. The move to a location adjacent to The Hays Corporation, which recently acquired Metrotype, will make possible better use of combined facilities.

Union Carbide Nuclear Company has appointed **Alvin M. Weinberg** director of Oak Ridge National Laboratory. In 1942, Dr. Weinberg joined the Manhattan District's Metallurgical Project, contributing to the design of nuclear reactors used in the production of plutonium. Since 1945 he has been associated with the National



ONE OF TWO WORTHINGTON CENTRIFUGAL COMPRESSORS keeping the temperature — and cost — *low* in ammonia processing at Lion Oil Company's plant. This unit cools a copper solution used to scrub NH_3; and chill and condense the compressed NH_3 gas to a liquid state.

Ammonia gets low-cost scrubbing and chilling with Worthington compressors

Every day 20 million cubic feet of natural gas are used in producing 300 tons of anhydrous ammonia at Lion Oil Company's Barton Plant in Luling, Louisiana — and nothing goes to waste!

Part of the credit for this efficient operation goes to two new Worthington centrifugal compressors which chill and scrub ammonia gas during the synthetic process. Unlike ordinary compressors, the new Worthington units employ interstage liquid ammonia injection — an exclusive feature that effectively reduces the heat of compression and thereby more efficiently converts velocity energy into pressure.

Choice of the Worthington compressors was based largely on this efficient design which has already introduced new economies into the Barton Plant operation. The centrifugal units, each rated at more than 1300 tons capacity, are powered by reliable Worthington steam turbines.

Worthington centrifugal compressors may be the answer to low-cost, high-volume processing in your plant, too. Find out how these units put big chilling jobs on a more profitable basis by writing Worthington Corporation, Air Conditioning & Refrigeration Division, Section A-5.61-PE, Harrison, N.J. A-5.61

WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME

This customer saved 46% in freight charges

on these stainless steel plates

THESE STAINLESS sketch plates, produced by G. O. Carlson, Inc., saved the customer 46% in shipping costs. If he had bought rectangular plates and done his own cutting, he would have paid freight on excess material which he could not use.

Then too, cutting and machining facilities were quite limited at the job site. Time and money were saved by having Carlson cut and machine the plates to the accurate tolerances specified.

For your next work involving stainless steel plates, heads and other stainless products, let us show you how—*and how much*—you save by buying from G. O. Carlson, Inc.

Stainless Steels Exclusively

G. O. CARLSON, INC.

Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

Suppliers . . .

Laboratory, holding the post of director of the Physics division and later research director of the laboratory. The company is a division of Union Carbide and Carbon Corporation.

Union Carbide and Carbon Corporation has consolidated its public-relations activities into one department and formed advertising departments for four of its division companies. **H. F. Bulkley** was named director of a new Public Relations department responsible for the corporation's public relations and stockholder relations, with **T. C. Fetherston** serving as his assistant, **George Sykes** as manager of the department, and **W. P. Burglund** as assistant manager.

Appointed to head up advertising departments of the division companies: Linde Air Products Company, **R. W. Boggs**; Carbide and Carbon Chemicals Company, **G. B. Moynahan**; Electro Metallurgical Company, **L. F. Granger**, and Haynes Stellite Company, **J. P. Reap.**

General Electric Company has elected **William A. Mann** as a commercial vice president. He has been assigned as resident officer in a newly-established regional headquarters in St. Louis. Mann had been central district manager of the company's User Industry Sales department in Chicago, and before that was manager of the Apparatus Sales office in Milwaukee.

Rockwell Manufacturing Company chairman of the board **Willard F. Rockwell** will assist in preparing a study on "Business Executives in the Federal Government." The project, underwritten by the Harvard Business School and the national Committee on Economic Development, will attempt to analyze and recommend solutions to the problem of getting good executives to help operate the government. Col. Rockwell, who also serves as chairman of **Rockwell Spring and Axle Company** will represent the Pittsburgh area. He is a former assistant to the Secretary of Defense.

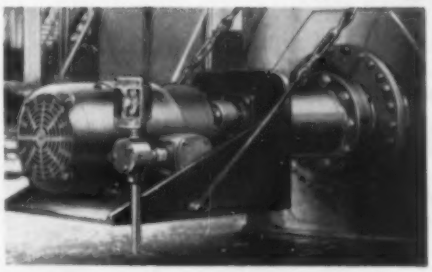
Tube Turns Plastics, Inc., has appointed **Theron S. Bushnell** as Midwest district manager. Bushnell, who will headquarter in Chicago, has a territory including Illinois, Indiana, Iowa, Minnesota, Wisconsin, Michigan, Ohio, West Virginia and Missouri. He also will service the Pittsburgh area.

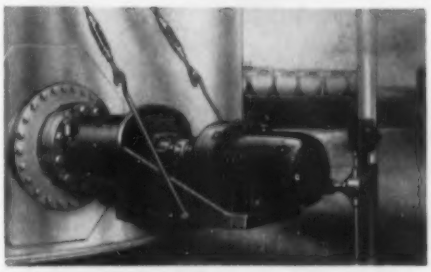
U. S. Steel Corporation has appointed **Ralph C. Moffitt** assistant vice president and director of purchases. With this appointment, Moffitt retains his present duties and takes on those of **R. L. Van Cleve**, assistant vice president for purchases, who is retiring after 41 years with the company.

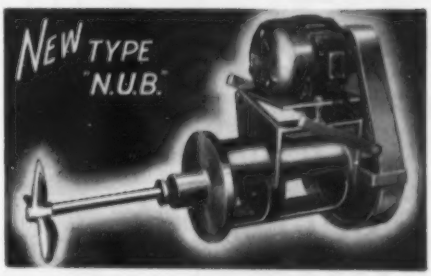
J. F. Pritchard and Company has made **Richard S. Brent** a district sales engineer in the company's Chicago office. Brent joined the company in 1952 as an application engineer.

Olin Mathieson Chemical Corporation has **Laurence S. Rockefeller** as a new member of its board. President of an investment and research organization formed to survey needs for venture capital, Rockefeller also is a director of

New! "International" SIDE ENTERING AGITATORS







Here are several good reasons why INTERNATIONAL excels in the primary essentials of efficient, economical and dependable performance.

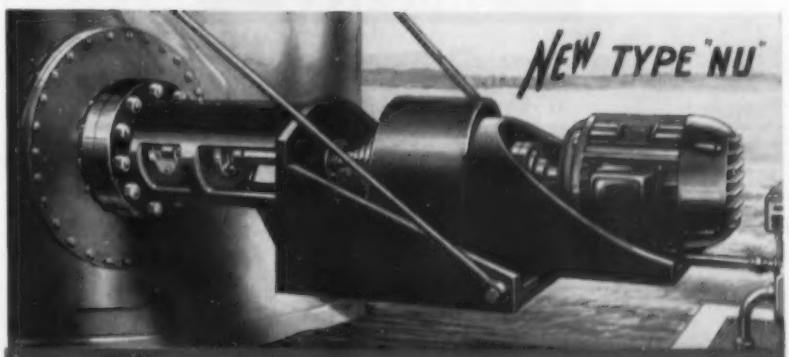
1—LARGER SHAFTS—eliminating undue wear and stuffing-box leakage caused by rotational deflection.

2—LINE BORED STUFFING BOX AND BALL BEARING SEATS—insuring perfect, permanent alignment of shaft and bearings—self adjusting. Even when taken down and assembled, simply tighten bearing bolts to replace shaft in original concentric position. No special skill or tools are needed.

3—NEW SHUT-OFF CONNECTION which allows Stuffing Box repacking with a full head of liquid, without appreciable leakage or disturbing other parts of the assembly. A much quicker and simpler operation than with conventional types.

4—MECHANICAL SEALS can be furnished as optional equipment at relative cost factor.

INTERNATIONAL Side Entering Agitators are designed for Continuous Heavy Duty Service—a complete line of Gearmotor, Roller Chain or V-Belt Drive in sizes from ½ to 30 H.P. Technical Bulletin 72-A available on request.



INTERNATIONAL ENGINEERING, INC.
DAYTON 1, OHIO
NEW YORK—15 Park Row CHICAGO—407 S. Dearborn St.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

Chase National Bank, Eastern Airlines, Inc., International Basic Economy Corporation International Nickel Company of Canada, a member of the New York Stock Exchange and chairman of Rockefeller Center, Inc.

Electric Steel Foundry Company has formed a new division, ESCO International, to handle its export business. Main office of the new division will be in New York, under the direction of **Ed. T. Hewitt.** Branch offices will be opened in San Francisco and Portland, Ore.

Clark Brothers Company has made **Charles J. Michelson** its district manager in Tulsa. Before joining Clark, Michelson had accumulated 11 years' experience in heavy machinery.

L. O. F. Glass Fibers Company has **Francis W. McPeek serving** as its district sales manager in the Cincinnati area, and **George R. Frick** is its newly-appointed field representative in the Boston area.

The company also has named **Thomas D. Leathers** as manager of its Pittsburgh area, and **G. O. Hartzell** has been appointed district manager at Toledo. **Ken C. Settelmyer** was made sales manager for the Midwest region, headquartered in Chicago.

The Dow Chemical Company has consolidated its Fine Chemicals Sales unit with the Organic Chemicals Sales section under the management of **James W. Harris.** With Dow since 1932, Harris has headed Organic Chemicals Sales for the past nine years. **Donald B. Black** will become product manager of Fine Chemicals Sales as a new unit of Organic Chemicals Sales.

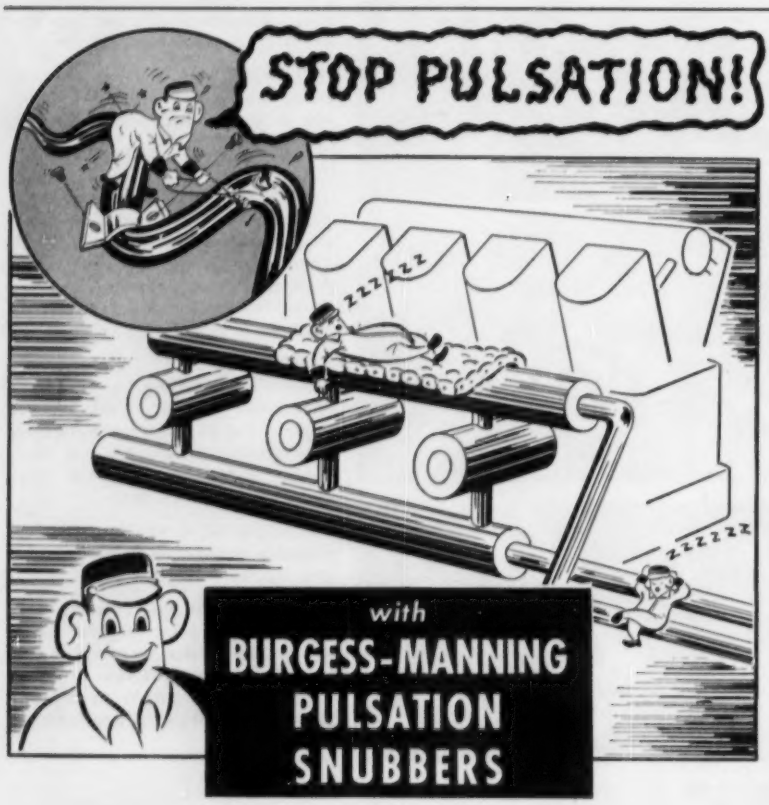
New York Air Brake Company has appointed **R. J. Murphy** as sales manager of its Hydreco and Dudco division. He will headquarter in Cleveland. He formerly was assistant sales manager for the two divisions. Before joining the company in 1953, Murphy was assistant sales manager of Sundstrand Machine Tool Company's Hydraulics division.

Hercules Powder Company has elected **George B. Baylis** an assistant treasurer of the company. With the company since 1918 and secretary since 1948, he will be responsible for problems involving banking, insurance and finance. **J. H. Tyler McConnell,** assistant to the president, was elected to succeed Baylis as secretary.

Deaths

William J. Shea, field representative for Goodyear Tire & Rubber Company, died recently while covering his territory. He had specialized in oil industry sales at Oklahoma City.

Howard T. DeRemer, works manager for Sales Corporation of America, died suddenly in Schwenksville, Pa., August 28, as a result of a heart attack.



with
BURGESS-MANNING
PULSATION
SNUBBERS

Burgess-Manning Pulsation Snubbers will remove one of your most aggravating and costly bug-a-boos, that of line surges from compressors, pumps, blowers, etc. Maintenance and service costs will drop sharply — lines and associated equipment will operate at a new efficiency — flow control can be greatly improved. Structural supports of pipe lines need no longer be of costly and special construction — gas compressors and pumps will deliver full design flow with greatest efficiency in pulse-free piping.

Send us your specifications for recommendations

Sound Engineering

BURGESS-MANNING COMPANY

711 East Park Avenue, Libertyville, Illinois

Dallas, Texas

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF PETROLEUM REFINER, published monthly at Houston, Texas, for October, 1955.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Ray L. Dudley, 3371 Chevy Chase, Houston, Texas; Editorial Director, Silas B. Ragsdale, 1636 North Blvd., Houston, Texas; Editor, George Gibbs, 1706 Vassar, Houston, Texas; Managing Editor, Wallace Fitzgerald, 1514 Hewitt Drive, Houston, Texas; Business Manager and Executive Vice President, A. L. Burns, 7 Chelsea Place, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; James Anderson, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; A. L. Burns, Houston, Texas; Grace C. Carter, Dallas, Texas; Margaret D. Cashman, Houston, Texas; P. Stinson Dudley, Eldorado, Texas; Ray L. Dudley, Houston, Texas; Wm. G. Dudley, Houston, Texas; Wm. V. Gross, Fort Davis, Texas; Carolyn Dodson Keeble, Abilene, Texas; Anita S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Walter Gage Sterling, Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois; Patricia McFarland Windham, Austin, Texas.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

A. L. BURNS,
Business Manager and Executive Vice President.

Sworn to and subscribed before me this 15th day of September, 1955.

P. J. AUCOIN,
(Seal) Notary Public in and for Harris County, Texas.
(My commission expires June 1, 1957.)

85,000 Sling Users Liked the First Edition ... NOW

FREE!

New expanded edition of our Famous Tuffy Sling Handbook... Mail coupon for copy today!

Tuffy's really tough. Bend it, loop it, jerk it. Tuffy's 9-part machine braided construction resists kinking. But if you are able to kink it by hand, see how easy it is to straighten out without damage.

Tuffy's pressed-on and swaged end ferrule eliminates rough edges that snag or catch. Smoothed edges protect hands, speed loading. Tucked-in splice is covered by new pressed-on ferrule—has 100 per cent of rated strength of the sling itself!

If you're a plant engineer, safety engineer, purchasing agent—if you use or buy slings—you need this new, enlarged edition of the most popular sling handbook ever published!

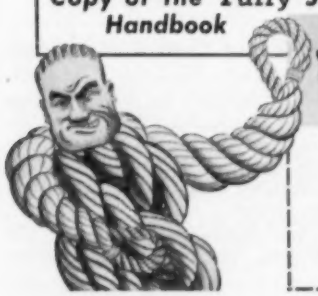
New types of factory fitted slings have been added to the Tuffy line. Now, old and new types are all made with a heavy walled steel ferrule. Ends of the ferrule are swaged flush with the machine braided strands leaving no projections to snag on loads. Many of the fittings—clamps, hooks, bridles, thimbles, saddles—are new, too. And this latest edition of the Tuffy Sling Handbook contains a host of other information you want and need for your job: a complete rigger's manual, authorized ratings and specifications for all Tuffy Slings; a new engineer's notebook; data tables on nearly a dozen versatile, easy-to-apply sling fittings.

But don't delay to order your FREE copy. Mail the coupon to us now. We'll send yours to you immediately.

CONSULT YOUR DISTRIBUTOR

when you want to buy Tuffy Slings or Tuffy Hoist lines to team up with your Tuffy Slings. Give him your requirements. He'll stock an inventory for you to draw against.

Mail Coupon For Your Free Copy of the Tuffy Sling Handbook



union Wire Rope corporation

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.

2284 Manchester Avenue, Kansas City 26, Missouri

MY NAME_____ TITLE_____

COMPANY NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

11

Use your process stream

to

NITROGEN DIVISION ALLIED CHEMICAL

STOP CORROSION

You can actually make your process stream stop its own corrosive action. Injected into the process lines, Barrett® Brand Anhydrous Ammonia flows right along with the gas stream, neutralizing corrosive hydrogen sulfide all along the way.

Hooked up directly from cylinders, Anhydrous Ammonia is easily vaporized. It stays with the gas stream through condensers, fractionating tower, heat exchangers, storage tanks, etc. Products of neutralization are easily eliminated; excess ammonia is removed by blowing the oil with air.

Normal operating schedules remain the same with Anhydrous Ammonia. Ammonia remains effective under a variety of climatic and operating conditions. At the same time its high solubility and high diffusion rates make it more efficient than other anti-corrosion agents.

Find out now how to preserve your valuable refinery equipment. Use Barrett Anhydrous Ammonia, available in 150, 100 and 50-lb. cylinders. Bulk quantities are also available.

Look for the green cap!

For technical assistance call or write your nearest Nitrogen Division office.

First in Ammonia Since 1890

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

Allied Chemical

Reviewing

Technical Speller, by Gessner G. Hawley and Alice W. Hawley. Here is a word book needed by every secretary who must use hard-to-spell scientific and technical terms. It contains more than 8000 difficult technical words selected from the vocabularies of chemistry, physics, engineering, electronics and other fields of science and technology. Also included are many common words of troublesome spelling which occur repeatedly in technical writing and correspondence. Many of these, such as names of complex chemicals and proper names, do not appear in desk-size dictionaries.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 146 pages, $2.95.)

Plastics for Corrosion-Resistant Applications, by Raymond B. Seymour and Robert H. Sheiner. Compiled from the authors' experience and research in the plastics field, this book supplies necessary background information for selecting the proper plastic for construction in corrosive atmospheres.

The book begins by describing the relationships between the chemical and physical properties and the molecular structure of plastics. Then follows information on their use as protective coatings, organic linings, chemical mortar cements, casting resins, plastic foams, impregnants, industrial adhesives and reinforced materials.

Other sections describe plastic pipe, ductwork, valves and fittings, and the use of plastics for corrosion-resistant floors, sumps and processing vessels. Plastics available for specific applications are compared in tabular form for easy selection of the most suitable material.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 411 pages, $7.50.)

Location Factors in the Petrochemical Industry. This government report, prepared by Massachusetts Institute of Technology, shows future patterns of petrochemical expansion will be somewhat less oriented to natural-gas-producing areas.

The study presents a location analysis of each of the various petrochemicals derived from methane, ethylene and acetylene, showing the major factors to be considered in location of petrochemical facilities are transportation costs on raw material and fuel gas, transportation costs on finished products and the economics associated with plant size.

(Office of Technical Services, Department of Commerce, Washington 25, 105 pages, $3.)

Problems and Control of Air-Pollution, edited by Frederick S. Mallette. Presented in this book are the proceedings of the First International Congress on Air Pollution, held in March 1955 by The American Society of Mechanical Engineers. The authors are authorities in the field of pollution control.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 272 pages, $7.50.)

New Books

Equilibrium Ratio Data Book, prepared by the National Gasoline Association of America. Many attempts have been made to define quantitatively the effects of composition on K-values. One approach was to define vapor-liquid behavior in terms of thermodynamic relationships and P-V-T behavior of pure hydrocarbons. This approach, which has promise of perhaps the highest degree of accuracy, is impractical for routine calculations.

A second approach, and this is the one used for the NGAA charts, was to relate K-values for hydrocarbons in the multicomponent system to those in the binary system. This was done with the Hadden "conversion pressure" concept. The basis for this concept is the assumption that K ratios in a complex mixture at a given temperature and pressure are identical with those in hypothetical binary systems having the same convergence pressure. The resulting K charts are useful in predicting K-values in mixtures containing any number of components.

The correlation of all directly-measured vapor liquid equilibrium ratios available through 1947, upon which the NGAA charts are based, was done at the University of Michigan. This tabular data was later converted into charts by The Fluor Corporation, Ltd., which also prepared charts for non-hydrocarbons based on data available through 1954.

The charts are available in two forms; complete in five-ring, looseleaf, heavy canvas binder at $12 a copy, or the contents alone, punched for a three-ring binder, at $9 a copy.

(National Gasoline Association of America, 421 Kennedy Bldg., Tulsa 3.)

Autohydrogeneration of Oil Gases, by H. A. Dirksen, H. R. Linden and E. S. Pettyjohn. This booklet, the result of a study sponsored by the American Gas Association, demonstrates the improvement autohydrogeneration would make in the availability of oil gases for natural gas. It covers the influence of catalytic type, operating conditions, feed gas composition and purification techniques, on the conversion of olefins and diolefins in typical high-Btu oil gases to paraffins, utilizing the hydrogen in the gas.

(Institute of Gas Technology, 17 West 34th Street, Technology Center, Chicago 16, 75 pages, $5.)

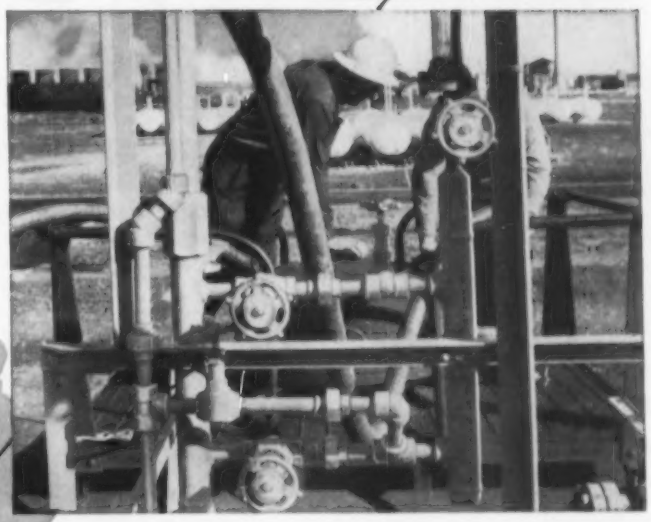
Product Flow Charts of the U. S. Chemical Industry, prepared by Standard Research Institute. This booklet containing comprehensive product flow charts of the U. S. organic and inorganic chemical industries, was designed for use by chemists and executives interested in knowing what raw materials go into what products.

Although no quantity figures are included, the materials are arranged in order of their descending importance with raw materials at the top of the charts. Volume of intermediates and end-chemical products is indicated in the same way.

The organic chart lists all organic chemicals with production volume more than 25 million pounds or $5 million in 1953, plus some which are expected to reach

WATSON-STILLMAN

FORGED STEEL FITTINGS



WORK BEST...under pressure

■ In high pressure steam lines... process liquid and gas piping... hydraulic fluid lines... wherever strong, tough pipe joints are needed. Watson Stillman Forged Steel Fittings provide a safety factor against costly piping failures. They resist pressure, heat, corrosion, shock and vibration because they're drop-forged of high quality steel to produce a dense, tough, forged-fiber structure that can really take it.

Extra strength is built into W-S fittings in other ways too... such as the heavy reinforcing bands extending well beyond the threads or sockets.

Protect your high pressure piping system with Watson-Stillman Forged Steel Fittings. Available in carbon, stainless and alloy steels, in Screw-End and Socket-Welding Types to meet your service requirements. Send today for Free Catalogs.

Bulletin A3-50—Forged Steel Fittings
Bulletin S-1-55—Stainless and Alloy Fittings
Bulletin U-1—Forged Steel Unions
Bulletin S-3-55—150 lb. Stainless Fittings

Sold Through Leading Distributors

WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

13

For more data on advertised products, use Readers' Service Cards, last page.

THE SPOTLIGHT'S ON NEW IDEAS

at the

25th EXPOSITION OF CHEMICAL INDUSTRIES

COMMERCIAL MUSEUM
and CONVENTION HALL

Philadelphia

Dec. 5-9

If you're a chemist . . . chemical engineer . . . production man . . . executive—there's no better, no easier way for you to keep up with today's developments than by taking time out to visit this important exposition! Over 500 informative exhibits throw the spotlight on the new facts, ideas, materials and methods that you must have at your fingertips.

At no other exposition in the country can you see so complete a display of the newest materials, supplies and equipment to serve the chemical processing industries. Hundreds of experienced technical representatives at the stimulating exhibits will bring you up to date on the newest processing methods. *Just a single idea picked up at this year's great EXPOSITION can profit you over and over again!*

Arrange NOW to come—and to bring your key men—to this important EXPOSITION. Write today for free advance registration and hotel accommodation forms to

MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY
480 Lexington Avenue, New York 17, N. Y.

New Books . . .

this volume soon. Raw materials include petroleum and natural gas.

(Stanford Research Institute, Chemical Economics Research, Menlo Park, Calif., $5.)

Petroleum and Natural Gas, prepared by the Bureau of Mines. The new fact book, to appear later as part of the bureau's Mineral Facts and Problems, is full of historical descriptions and items about current sources and uses of petroleum and natural gas.

It describes the first oil refinery and goes on to show that contrary to popular impression, a handful of companies do not control the oil and gas industries. Rather, many thousands of business establishments are reported as involved every phase of handling oil and gas.

Mineral Facts and Problems, to contain 87 chapters on the U. S. mineral industry, will be ready in a few months. All the chapters, like the one on petroleum and natural gas, will complete reference works on specific subjects.

(Superintendent of Documents, Government Printing Office, Washington 25, 40 cents.)

The Automatic Factory—A Critical Examination, by Stephen A. June, John D. Bardis, Lee H. Lurio, Leonard S. Polaner, Oystein Sagedahl, Herbert A. Sklenar and Bernard K. Yenkin. This report, prepared as part of the requirements for the manufacturing course at Harvard Graduate School of Business Administration, attempts to bridge the gap between the theoretical concepts and actual industrial developments of the automatic factory.

It was written principally for businessmen in an attempt to clarify and expose the sometimes hypothetical and imaginative writings of scientific and commercial authors. Dreaming and guesswork were purposely omitted. The authors reasoned that automatic factories would have a profound effect on future manufacturing processes and felt a purely objective viewpoint would more likely bring the automatic factory into proper perspective for those who may now view automation through biased eyes.

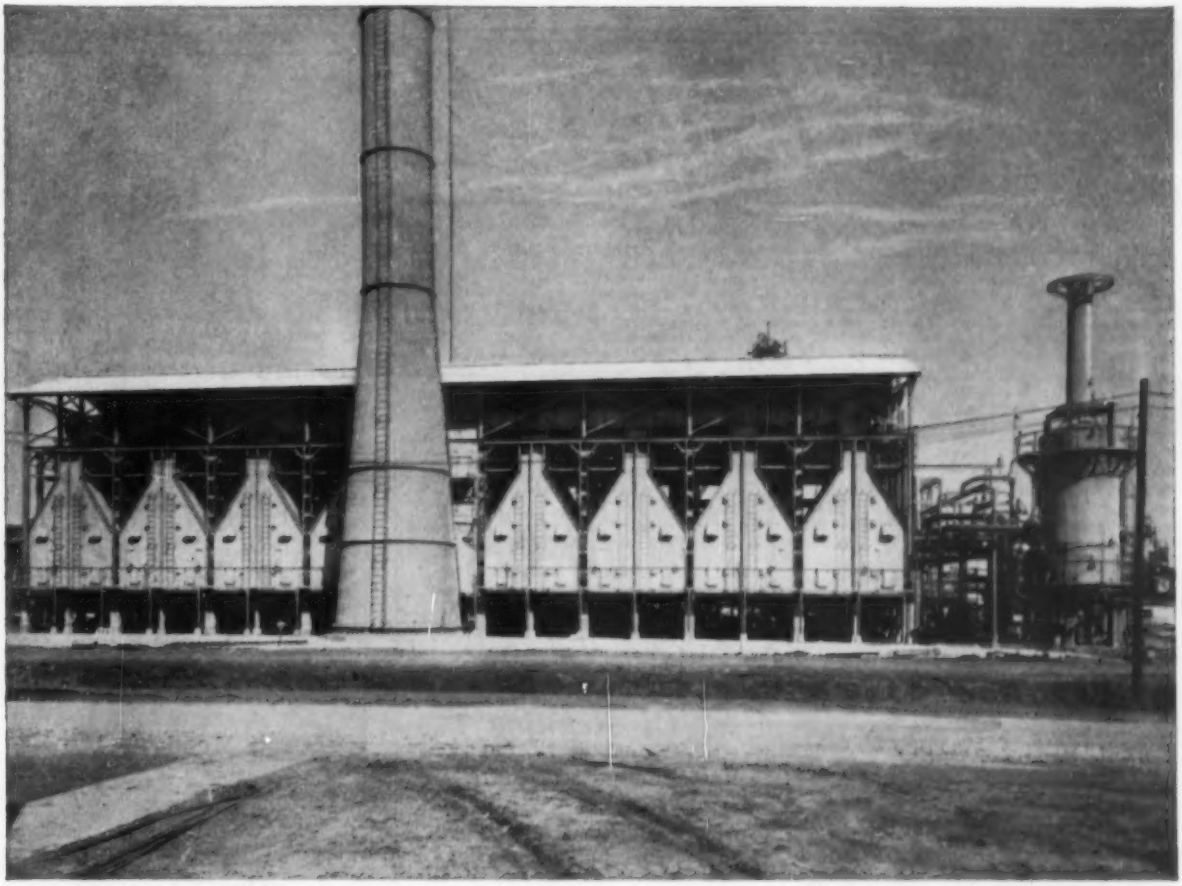
(Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, 74 pages, $1.50.)

Fifth Symposium on Combustion, prepared by the Standing Committee on Combustion Symposia of the Combustion Institute. This volume contains 101 papers presented at the Fifth International Combustion Symposium held at the University of Pittsburgh in 1954. The work of 182 contributors from all parts of the world, this book offers a complete, authorative, up-to-date body of knowledge on the combustion problems involved in the operation of all type engines.

Forty-five papers deal with kinetics of combustion reactions, while the other papers cover the combustion of fuel droplets, combustion of solids, propellant burning, special techniques and instrumentation, diffusion flames and carbon formation, flame spectra and dissociation energies and special processes in engines. Eleven papers discuss unsolved problems in various type engines and basic kinetic problems, including high-temperature kinetics.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 802 pages, $15.)

For more data on advertised products, use Readers' Service Cards, last page.



200 million pounds of Ethylene can be produced yearly by this bank of eight ethane cracking furnaces at the Tuscola, Illinois plant of National Petro-Chemicals Corporation, (a joint enterprise of National Distillers Products Corporation and Panhandle Eastern Pipeline Company). Largest single installation of its kind to date, these furnaces, operating above 1500F°., produce ethylene by cracking ethane in Incoloy tubes.

Incoloy tubes perform successfully in hydrocarbon cracking furnaces

The Incoloy* tubes in the ethane cracking furnaces shown above have now given two years satisfactory service — with promise of more to come. Operating temperatures are in excess of 1500°F. A number of installations in other plants have given as much as four years' service in cracking ethane and propane for production of ethylene.

The reasons? Incoloy has high creep and rupture strengths at elevated temperatures. It resists carburization and is stably austenitic. After prolonged exposure to intermediate temperatures, Incoloy shows only slight tendency to become embrittled by carburization and none at all due to structural changes.

You can use Incoloy at temperatures right up to 1800°F. And it gives an improved safety factor in decoking where temporary hot spots may occur.

Incoloy offers economy

In addition to improved performance features, Incoloy also offers a decided price advantage, compared with certain alloys, when it is used as extruded tubing.

Comparatively low thermal expansion and good weldability are other characteristics that make Incoloy an attractive material for this application.

If the severe conditions involved in hydrocarbon cracking or in natural gas reforming are a problem to you, why not consult our High Temperature Engineering Section? They will be glad to help you without cost or obligation.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

*Registered trademark of The International Nickel Company, Inc., applied to a nickel-chromium-iron alloy produced and marketed by it.

INCO TRADE MARK **Incoloy**

For more data on advertised products, use Readers' Service Cards, last page.

PETROLEUM REFINER Classified Ads

Petroleum Refiner New Classified Rates

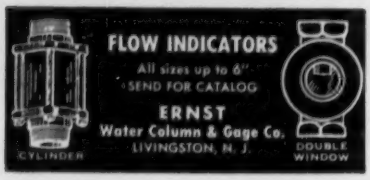
RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situations wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

FOR SALE

■ HIGH voltage electrodeless discharge is on its way as one of the new tools in petroleum refining. High voltage discharge eliminates sludge formation! High voltage discharge removes gases and water! High voltage discharge improves high temperature greases! High voltage discharge makes lubricants from non-lubricants! Let us demonstrate the use of this new tool. No obligation, of course. Research and Development Corporation, 21 East Van Buren Street, Chicago 5, Illinois.

■ FOR SALE: One 40′ x 8″ neoprene suction and discharge hose with built in nipples. Has place about 8 inches x 1 inch rubbed through to metal reinforcing about 10 feet from one end. This is a bargain. Contact H. Howarth. Freight Claim Agent Santa Fe Railway, Galveston, Texas.



HELP WANTED

Plant Equipment Inspectors

Senior Inspectors for company operation in Saudi Arabia and company engineering department in The Hague, Holland. Should be graduate engineers with minimum 8 years' experience in design or inspection of petroleum processing plants and equipment, 5 years' actual inspection experience necessary.

In Saudi Arabia—will advise operating department on code and equipment limitations, develop inspection methods, supervise and conduct inspections.

In The Hague—will inspect and approve equipment and material purchases, advise and assist foreign manufacturers to comply with U.S. Standards and Specifications.

Salary commensurate with education and work experience. Write giving full particulars regarding personal history and work experience.

Recruiting Supervisor, Box 73

ARABIAN AMERICAN OIL COMPANY

505 PARK AVENUE
NEW YORK 22, NEW YORK

HELP WANTED

ENGINEERS

Chemical and Oil Refining

Furnace Builder requires engineers with experience in design and operation of processing heaters used in petroleum and chemical industries — location New York. Salary, incentive plan and excellent working conditions.

Box 211-R, *Petroleum Refiner*, Houston, Texas.

SUPERINTENDENT ORGANICS PRODUCTION

We have an excellent opportunity for a man with a B.S. or advanced degrees in chemistry or chemical engineering as Superintendent of petro-chemicals production for a medium-sized chemical company located in the Detroit area. A minimum of seven years' supervisory experience in organics production is required. Please submit a complete resume, including salary requirements, in first letter. Box 209-R, Petroleum Refiner, Houston, Texas.

PROFESSIONAL SERVICES

UP TO 2000 FOOT DRAIN LINES CLEANED FROM ONE OPENING!

Chemical lines a specialty
FREE Estimates, References
Call or Write

ROTO-Rooter

LINE — SEPTIC — COOLING TOWER CLEANING
2023 Westheimer — JA 8-5301 — Houston

HELP WANTED

DESIGN ENGINEERS

PERMANENT OPPORTUNITIES

At Our Cleveland, Ohio, Offices with an engineering firm having over 50 years of successful operation doing business all over the world.

The McKEE Organization continues to grow and expand and continues to offer many permanent present and future opportunities for qualified, experienced ENGINEERS and DESIGNERS in the following fields:

—STRUCTURAL STEEL
—CONCRETE
—ELECTRICAL
—HEAVY MACHINERY
—PIPING
—PROCESS HEATERS
—EQUIPMENT SPECS
—ARCHITECTURAL
—MECHANICAL

Applicants should have at least 5 years of good design experience in any of the above fields. Applicable to heavy construction as described below—

McKEE designs and constructs Blast Furnaces, Open Hearth Furnaces, Sintering Plants and Auxiliary Facilities; Oil Refineries, Chemical and Petro-Chemical Plants. All of these afford a wide diversification of opportunities to energetic and qualified Engineers.

HERE IS AN OPPORTUNITY FOR YOU TO UTILIZE YOUR ABILITIES AND TALENTS AS A DESIGN ENGINEER!

McKEE Offers Top Compensation commensurate with experience and ability. No age limitations.

In addition to Good Earnings, Permanency and Opportunities, McKEE offers a Pension Program to qualified persons, Liberal Vacation and Sick Leave, Insurances, Promotion from within the organization. Transportation and Moving Allowances; an excellent job evaluation and merit-rating program as well as the best in working conditions in air-conditioned offices.

Please Send Resume To:
Edward A. Kolner
ARTHUR G. McKEE & CO.
2300 Chester Ave.
Cleveland 1, Ohio

REFINER Classified Ads Don't Cost . . . They Pay

HELP WANTED

SAFETY ENGINEER

CALTEX has position available in Indonesia for a man who meets the following requirements:

- AGE—30-45 years.
- EDUCATION — Prefer college graduate.
- EXPERIENCE—Minimum 5 years in Fire & Accident Prevention work in petroleum or similar industry, involving organization and administration of complete program.

Salary commensurate with background and experience plus foreign premium, quarters and living allowance and complete employee benefits. If married, must be agreeable to one year's separation.

Send detailed resume to:

CALIFORNIA TEXAS OIL CO., LTD.
380 MADISON AVENUE
NEW YORK 17, NEW YORK
c/o Personnel Dept.

Position available
for a

PROJECT MANAGER

at the

M. W. KELLOGG CO.

. . . a position with the career potential only a top-ranking firm can offer. The man who fills it will be the "job architect" supplying the technical information required for design and development of oil refineries and chemical plants . . . lending his extensive experience to every phase of the project . . . and maintaining considerable liaison work with the customer.

A degree in chemical or mechanical engineering with 8 to 10 years' diversified experience in the petroleum and chemical industries are minimum requirements. The right man for the job will know the others, in terms of initiative, ability and personality.

Interested persons should send complete details, including salary requirements to Mr. R. L. Stacom.

M. W. KELLOGG CO.
225 Broadway
New York 7, New York

PROCESS DESIGN ENGINEER

If you have a degree in chemical engineering and 5 to 10 years of diversified process design experience in petroleum and chemical industries, and are interested in a process design position with a future, you should consider joining the McKee organization.

Please send complete personal details including salary requirements to:

Edward A. Kolner
ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
CLEVELAND 1, OHIO

Engineers
Designers

CHEMICAL — MECHANICAL
ELECTRICAL — STRUCTURAL
PIPING

San Francisco Assignment

Recent design experience on petroleum refineries, chemical plants or related projects.

Piping Draftsmen

All Classifications

Salary commensurate with qualifications and experience. Liberal moving allowances.

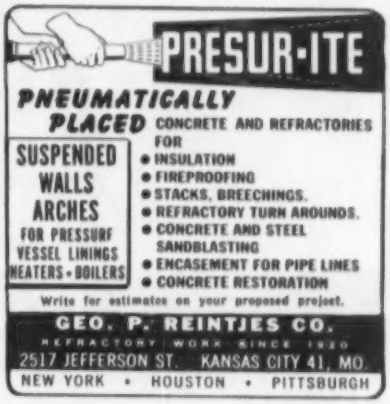
Write furnishing complete particulars regarding educational qualifications, work and salary history, salary desired, business and character references.

Bechtel
CORPORATION

220 Bush St., San Francisco 4, Calif.

■ PROCESS ENGINEER—Engineering graduate experienced in the process design of various types of petroleum refining process units required by a midwestern engineering and construction firm. Please submit resume and photograph indicating education, experience and salary requirements to Box 210-R, c/o Petroleum Refiner, Houston, Texas.

■ REFINERY ENGINEER. Registered professional and graduate mechanical engineer. Over 15½ years responsible and supervisory experiences includes: 5½ years in design of hydro and hydropneumatic systems; 4½ years in refinery and petrochemical design and construction with major refinery contractor; 5½ years refinery engineering, maintenance and construction with independent and major oil companies. Box 212-R, Petroleum Refiner, Houston, Texas.


PRESUR-ITE
PNEUMATICALLY PLACED CONCRETE AND REFRACTORIES FOR
SUSPENDED WALLS ARCHES
FOR PRESSURE VESSEL LININGS HEATERS • BOILERS
• INSULATION
• FIREPROOFING
• STACKS, BREECHINGS.
• REFRACTORY TURN AROUNDS.
• CONCRETE AND STEEL SANDBLASTING
• ENCASEMENT FOR PIPE LINES
• CONCRETE RESTORATION
Write for estimates on your proposed project.
GEO. P. REINTJES CO.
REFRACTORY WORK SINCE 1920
2517 JEFFERSON ST. KANSAS CITY 41, MO.
NEW YORK • HOUSTON • PITTSBURGH

GUNITE
Since 1915
CONCRETE
SAND AND CEMENT
"Placed by Air"
We have the equipment, personnel and experience to complete any and all GUNITE work regardless of size or location.
Send for specifications and bulletins
See our catalog in Sweet's
GUNITE CONCRETE & CONST. CO.
1301 WOODSWETHER RD., KANSAS CITY 5, MO.
2016 W. WALNUT, CHICAGO 12, ILL.
3206 HOUSTON, HOUSTON 9, TEX.
St. Louis · Milwaukee & Twin Cities Denver
New Orleans · Memphis

MEASURE, CONTROL LIQUID DENSITY
continuously and automatically with the

Princo Densitrol

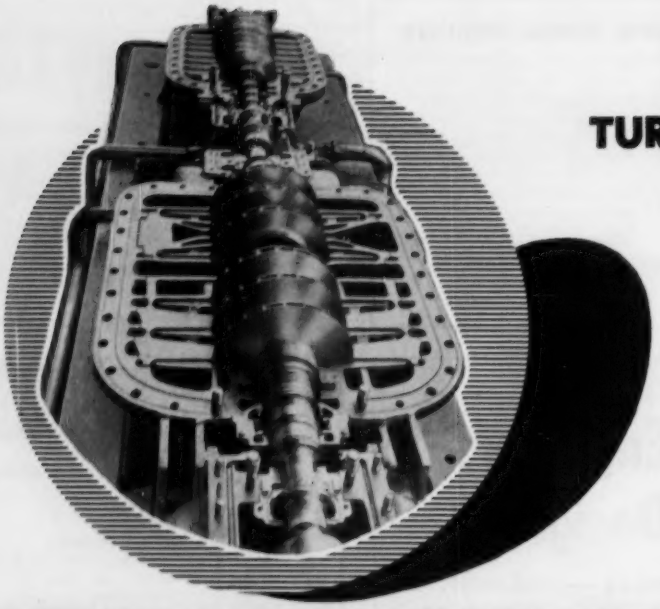
PRINCO

Measures and controls liquid density continuously in any pipe line set up. Many uses: controls density of "in process" chemicals like oleum; controls density of hydrocarbon fuels, alkylated acids, wax streams, etc. during refining; controls density of component solutions during blending of cutting oils, solvents, gasoline additives and other petro-chemical compounds. Can be installed for automatic control with remote instrumentation.

Explosion-proof models and automatic temperature compensation also available. For ranges, calibrations, and other specifics, ask for Bulletin W-4.

PRECISION THERMOMETER & INSTRUMENT CO.
1434 Brandywine Street, Philadelphia 30, Pa.

For more data on advertised products, use Readers' Service Cards, last page.



TURBO COMPRESSORS

GAS CIRCULATORS
BLOWERS
EXPANDERS
PRESSURE VESSELS
HEAT EXCHANGERS
COLUMNS

GUTEHOFFNUNGSHÜTTE
STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

REPRESENTATIVES: **THE FORAM CORPORATION**
76 Beaver Street, NEW YORK 5, N. Y. · Telephone: WHitehall 3-3881

Prolong the Life of Vessel Liners by Armoring them with . . .

KLEMP **HEXTEEL** ▶

Hexteel is an armor and retainer for castable refractory monolithiclinings used for cat crackers, reactors, regenerators, fractionators, heaters, strippers, risers, stacks, cyclones, ducts, breeching, furnaces and tanks.

and FLOORSTEEL ▶

Floorsteel is an armor and retainer for monolithic liners applicable to small diameters for pipe linings, heads, plenum chambers, sumps, stacks and furnaces.

Hexteel and Floorsteel carbon or stainless steel armors and retainers prolong the life of vessel liners by resisting abrasion and corrosion. Our engineering department is prepared to design your total lining requirements. Whatever the destination, we will deliver your Hexteel or Floorsteel world-wide in record time!

Emergency delivery of Klemp Hexteel via air transport

Write for your FREE copy of "Klemp Data and Specification Manual."

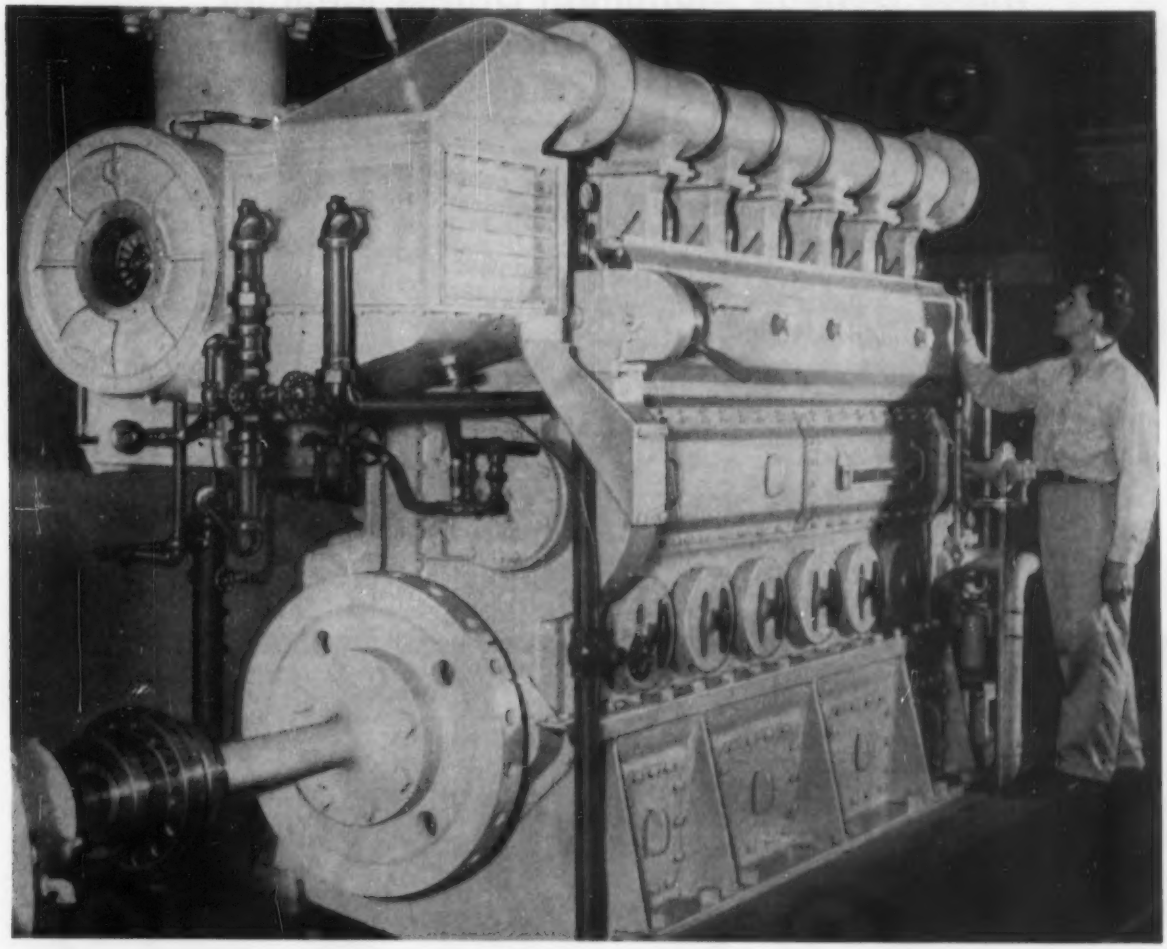
KLEMP METAL GRATING CORP
6601 South Melvina Avenue
Chicago 38, Illinois

KLEMP METAL GRATING CORPORATION
6601 South Melvina Avenue, Chicago 38, Ill.

Gentlemen:
Kindly send me a copy of your "Data and Specification Manual."

Name_____
Firm_____
Address_____
City_____ Zone____ State_____
Phone_____

What's New In Equipment . . .



New diesel engine is designed for a variety of jobs.

New Medium Speed Engine Gives High Performance

A New Design in moderate speed, 4-cycle, heavy duty diesel, dual fuel, and gas engines with ratings up to 1400 horsepower has been announced by Worthington Corporation. The new medium speed engines are designed for service in a wide variety of industrial applications. The engine is available with both normal aspiration or exhaust turbocharged intake. This unit has been designated the W9 line and has a specially designed air inlet which brings the air in parallel to the inlet valve stem and gives it a swirl as it enters the cylinder. This feature is intended to introduce larger and more turbulent air charges into the cylinders giving cleaner and more complete combustion. The engine is designed throughout for high pressure turbocharging and is structurally designed for operation at higher than 200 psi, bmep.

Welded steel construction of the W9 affords a low weight per horsepower ratio thus providing lower building, foundation and installation costs. The engine may be arranged as a drive unit for either end, and may be equipped with any of the standard clutches, hydraulic couplings, torque converters or other power take-off equipment now on the market. The welded steel frame design still allows the use of cast iron cylinder liners with water jackets cast integrally. The crankshaft is hung from the frame; secured by heavy cast steel main bearing caps, and utilizes removable precision bearing shells. Jacket water does come in contact with the steel frame and thus the corrosion of the steel or leakage of water to the crankcase is avoided.

Use of the liner with integral water jacket permits withdrawing the piston, connecting rod, and liner as a complete assembly, thus simplifying maintenance procedures. The relatively small volume in

PERFORMANCE AND PRICE...

make Benson Aluminum Drums Ideal for Norda Essential Oil & Chemical Company, Inc.

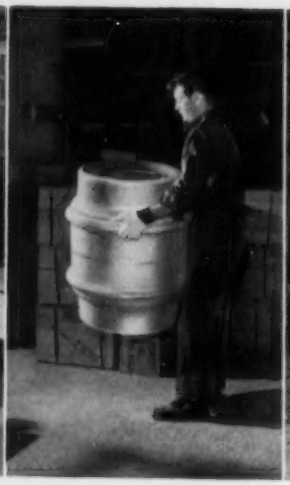
PROBLEM:

Shipment of aromatic and essential oils for cosmetics and food stuffs by Norda Essential Oil & Chemical Co., New York.
(Galvanized and steel drums cause contamination of oil products. Glass containers too fragile—stainless steel too expensive.)

SOLUTION:

Purchase of 600 Benson Aluminum Drums
(Strong, light, corrosion resistant aluminum drums prevent contamination, are highly durable, provide easier handling and storage.)

Light weight of aluminum drums facilitates handling and shipping.



Aluminum drums protect against contamination and shipping damage.

Durable aluminum drums have a long, useful life—despite hard usage.

First cost alone is only the beginning of the savings advantages of Benson Aluminum Drums. Replacements are less frequent—aluminum drums won't rust or shatter. Light weight saves on handling and shipping charges. There are no costs for application of protective coatings . . . no losses through contamination of chemical contents. For further information contact the Reynolds office listed under "Aluminum" in your classified directory or write *Reynolds Metals Company, P.O. Box 1800-CT, Louisville 1, Ky.*

REYNOLDS ALUMINUM

EXCLUSIVE SALES AGENTS FOR BENSON CHEMICAL DRUMS

New Equipment . . .

the water jackets results in high cooling water velocity through the jackets thus providing desirable cooling effect. This high water velocity makes the engine particularly adaptable for use with high temperature cooling systems which are becoming more and more popular.

When the engine is equipped for dual-fuel operation, the gas admission valve is installed in the air inlet passage and is operated by the air inlet valve rocker arm. By using this arrangement, the gas and air are intimately mixed before entering the combustion space. Thus, the gas valve can be kept open longer allowing use of fuel gases at lower pressures.

Turbocharged models are equipped with the latest type high-pressure centrifugal turbochargers. Exhaust gas is delivered to the turbocharger through a dry type insulated exhaust manifold. The air inlet manifold mounted on top of the cylinder heads is made in removable sections permitting removal of any of the individual cylinder heads without removing the entire manifold.

Full pressure lubrication is provided by high capacity lube oil pump driven from the engine crankshaft mounted at the end opposite the fly wheel. Oil is delivered through a header at the top of the main bearings leaving the main bearing cap free of fittings to permit easy removal. Oil for lubrication of the full floating wrist pins and the piston crown is delivered through rifle-drilled passages in the connecting rod. For additional information on this unit . . .

This item supplements Worthington Corporation data on pages 897-912 of The Refinery Catalog, 22nd Edition.

Circle E1 on Postcard

Gas Density Balance . . . Arnold O. Beckman, Inc., has announced a new instrument which measures the density of a sample gas by a null balance principle. A small dumbbell is supported on a horizontal quartz fiber. One ball of the dumbbell is punctured so that it will not experience bouyancy effects. The other ball tends to raise or dip as the density of the gas increases or decreases. Thus, the dumbbell creates a rotational force about the quartz fiber as it responds to density changes.

The magnitude of this force is pro-

...You can't beat these drop-head dies for easy work, perfect threads... and long trouble-free service!

Every RIDGID Pipe Tool TESTED before shipment

RIDGID

Drop-Head Dies for ⅛" to 2" pipe

Each size die head snaps instantly into ratchet handle. Dies reverse quickly for close-to-wall threads, easily removed for regrinding. Left hand dies available.

00R, ⅛" to 1"
111R, ⅛" to 1¼"
12R, ⅛" to 2"

Buy them from your Supply House.

Every RIDGID Pipe Tool individually TESTED before shipment.

Carrier free with complete sets.

The Ridge Tool Company • Elyria, Ohio • U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

Pick the Right Evaporator!

Here's how to evaporate light, low boiling point fractions of viscous mixtures.

The Whitlock Falling Film Evaporator is designed to do this job most economically and efficiently. It is accurately manufactured to rigid standards to assure the proper liquid distribution so important in the evaporating process . . . The tube ends are ground to precisely the same heights to provide uniform flow of the fluids in ALL the tubes. Whitlock engineering and fabricating techniques combine to produce an evaporator of unsurpassed performance.

Evaporators are only one Whitlock Product . . . we design and build *all* types of heat exchangers for the Processing Industry. Whatever your requirements, whether standard or special, you can depend on Whitlock's long experience. Write for recommendations and Bulletin 250. The Whitlock Manufacturing Company, 75 South Street, West Hartford 10, Connecticut. In Canada: Darling Brothers, Ltd., Montreal.

- **Evaporators of straight tube — fixed tube sheet design, incorporating standard Whitlock shell side expansion joints.**
- **Tube ends ground square with maximum elevation difference of ± .005".**
- **Distribution ferrules individually ground to inside diameter tolerance of + .001, — .000.**
- **Ferrules tangentially slotted in 3 positions provide proper liquid distribution.**

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

New Equipment . . .

portional to the density of the sample gas. A 95 percent response is obtained in less than one minute. Sensitivity is ½ percent of full scale; accuracy is ½ percent of full scale. Ranges of 0.100 total span relative to air anywhere from 0 to 2.000 are available. Multiple range instruments may be supplied with a total span of 1.000 relative to air in five consecutive steps of 0.200, starting anywhere from 0 to 2.000. Continuous samples or samples as small as 10 cc may be measured. For more information . . .

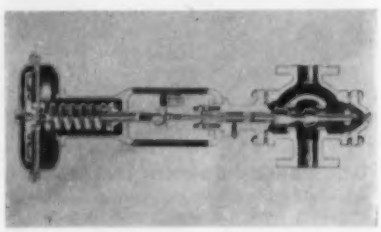
Circle E2 on Postcard

PVC Pipe Fittings . . . Tube Turns Plastics, Inc., has announced commercial scale molding of 3-inch and 4-inch pipe fittings of unplasticized polyvinyl chloride (PVC). Included are 90 degree and 45 degree elbows, tees, couplings, and flanges. The larger size PVC fittings make possible the economical erection of the larger size PVC piping systems now being contemplated.

All of the fittings are available for ½-inch up, in normal and high impact PVC, and in threaded and socket types, the latter designed for attachment to pipe by solvent or fillet welding. The fittings are made by the exclusive Hendry injection moulding process. For further information . . .

Circle E3 on Postcard

This item supplements Tube Turns Plastics, Inc., data on pages 842-843 of The Refinery Catalog, 22nd Edition.



Motor Valve . . . Fisher Governor Company announces its new motor valve series 657 direct acting and series 667 reverse acting. The new units have a bolted-clamp type stem connection which allows stem adjustment of 50 percent of total travel in either direction. It will not shake loose from vibration or rotational inner valve forces, and it can be disconnected

WIRE MESH

Jelliff

Specializing in the non-ferrous metals
in counts to 200 x 200 or 50 x 750
and widths up to 48" in all commercial weaves

IN MESH WITH INDUSTRY

Since
1880

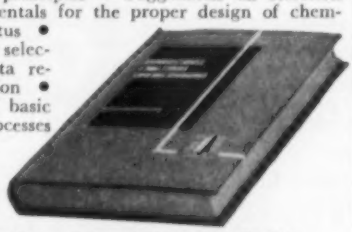
address your enquiries to Department 16

The C. O. JELLIFF MFG. CORP.
SOUTHPORT • CONNECTICUT • USA

WIRE PRODUCTS Jelliff SINCE 1860

A handy reference guide giving you—

• Concise statement of principles • Suggestions on selection of equipment • Fundamentals for the proper design of chemical engineering apparatus • Helpful hints on proper selection and full use of data recorded in experimentation • Thorough description of basic chemical engineering processes



PRINCIPLES of CHEMICAL ENGINEERING

By WILLIAM H. WALKER, WARREN K. LEWIS, WILLIAM H. McADAMS
Professors of Chemical Engineering, Massachusetts Institute of Technology
AND EDWIN R. GILLILAND
Associate Director, Laboratory of Nuclear Science and Engineering, MIT

**Fully revised Third Edition, 749 pages, 6 x 9,
227 illustrations, $8.00**

This book concisely and thoroughly presents those principles upon which chemical engineering operations are based, and develops methods for applying these principles to the solution of problems in chemical engineering practice. The opening chapters, which review principles of measurement, laws of fluids, heat, etc., are followed by extensive material on the operations of chemical engineering, including descriptions of processes and equipment and full treatment of problems and methods of design. Special attention is given to illustrative problems and solutions that give helpful suggestions relative to the plan of an experimental run, the data to choose, and the method of solution and interpretation to adopt.

Throughout this revised edition, emphasis is laid on the importance of material and energy balances, equilibria, and rate relationships, and the technique of using these in solving practical problems. Widespread advances in chemical engineering are fully covered in much new or thoroughly rewritten material.

Send Orders to

THE GULF PUBLISHING COMPANY

P. O. Box 2608 Houston, Texas

NO.2 in a series of **ALUMICOAT APPLICATIONS**

RESISTS HIGH TEMPERATURE CORROSION!

Alumicoat

Molten Aluminum

PROCESS PROTECTS REFINERY EQUIPMENT

More and more refineries are discovering the advantages of the new ALUMICOAT Process! ALUMICOAT offers a firm resistance against corrosive media — *especially sulphur compounds* — and extreme temperatures!

In the ALUMICOAT Process, refinery parts are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The Alumicoat Process can solve your corrosion and oxidation problems. Send for full details today!

ARTHUR TICKLE ENGINEERING WORKS, INC.

26 Delevan Street MAin 5-4200 Brooklyn, N. Y.

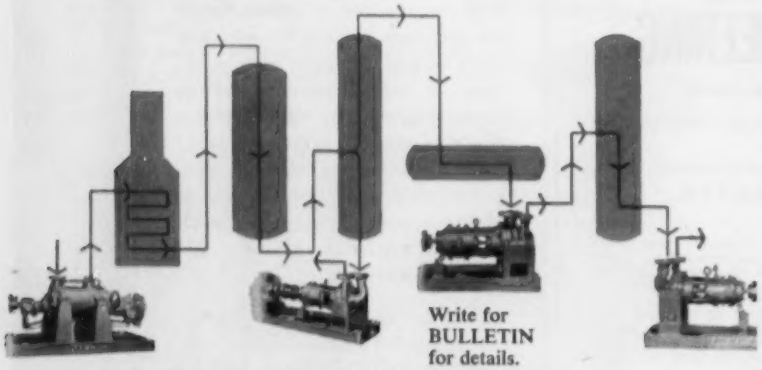
PACIFIC®

The name to remember when your problem is to start the charge stock and to keep it and its fractions moving without interruption on their guided tour through your process unit.

PACIFIC PROCESS PUMPS INSURE MORE SERVICE FOR YOU AND LESS SERVICING BY YOU

because

1. ***Design proportions are not limited*** to "just enough."
   Extra heavy metal sections, identical bolting for glands and seal plates are combined with selected materials of construction to provide that "extra margin" needed to extend use life in corrosive-erosive services.
2. ***Guided inlet flow*** reduces prerotation and friction losses ... insures minimum required NPSH.
3. ***They are balanced—dynamically—radially—axially—eliminates—*** vibration that would cause damage to rings ... bushings ... bearings ... packing or mechanical shaft seals ... excessive radial and thrust loads on bearings.
   Increases—availability for profitable operation.
   Decreases—down time for maintenance.
4. ***Positive lubrication of bearings***—oil rings pump oil up into bearing cap from where it must flow through—not around—the bearings back into the oil reservoir—contributes to trouble free operation ... longer bearing life ... low maintenance.
5. ***Labyrinth seal*** in each bearing cap ... no contact between shaft and seal ... keeps oil in and dirt out of bearings—prevents contamination of lube oil—contributes to trouble free operation—low maintenance.



Write for BULLETIN for details.

Custom Designed, Engineered and Manufactured by:

PACIFIC PUMPS INC.

One of the Dresser Industries

HUNTINGTON PARK, CALIFORNIA

Offices in all Principal Cities

CP-13

New Equipment . . .

in the field without damage to the stem. Diaphragm casings are drawn steel. Special designed Buan N molded diaphragms with Nylon insert retain superior flexibility at low ambient operating temperatures. For additional information . . .

This item supplements Fisher Governor Company data on pages 389-400 of The Refinery Catalog, 22nd Edition.

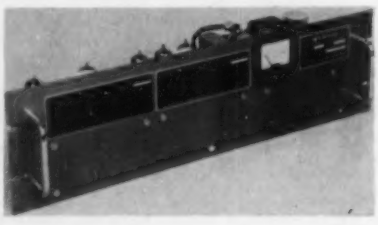
Circle E4 on Postcard

Tube Expanding Control . . . Elliott Company's Lagonda Division has developed a new electric control for tube expanding that assures the same expansion of each tube after metal-to-metal contact regardless of small variations in size of the tube and tube sheets. The control is a torque-limiting device designed for use with any standard tapping motor.

The control features a voltage balancer. This balancer eliminates the need for voltage regulator by automatically balancing all outside voltage variables that effect the calubration of the control. Once the voltage is balanced, the torque control set, no further adjustment is needed during the tube rolling operation except an occasional check on the voltage balance. For additional information . . .

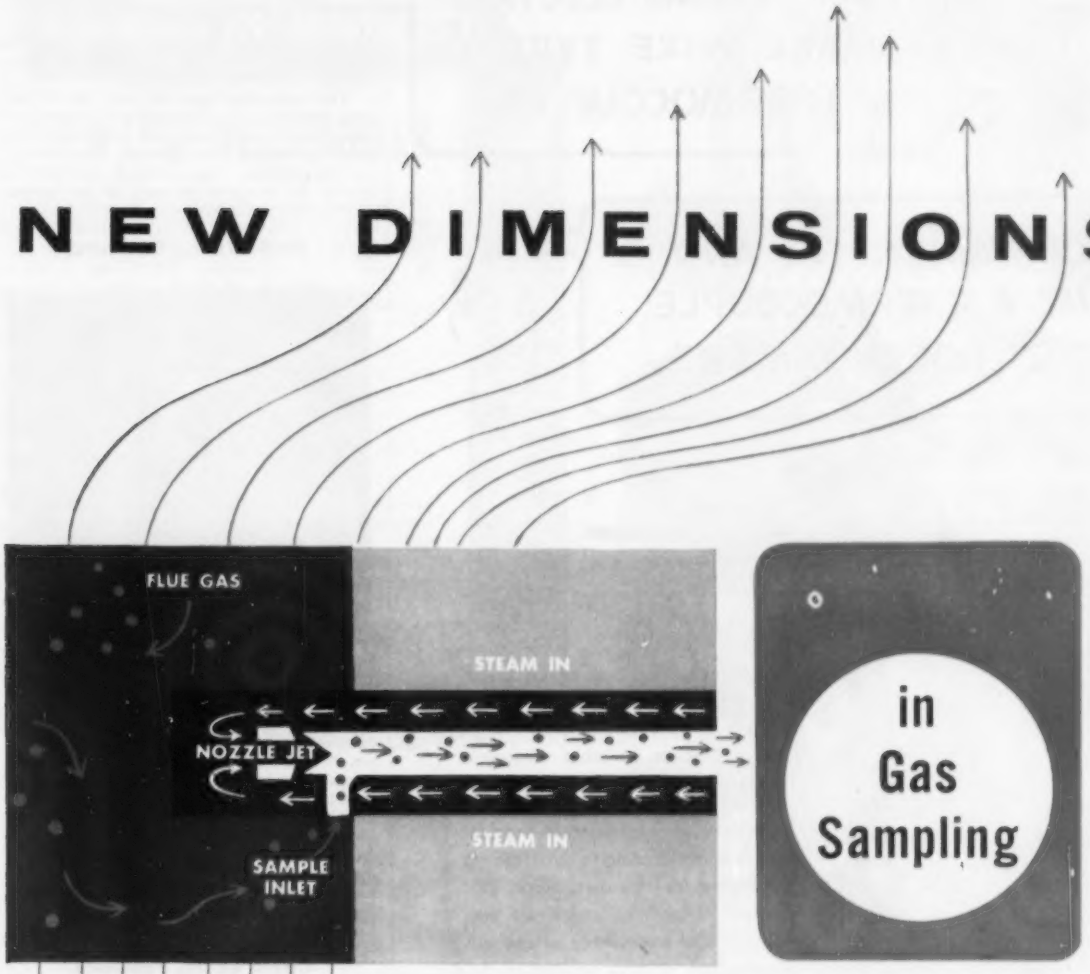
This item supplements Elliott Company data on pages 361-368 of The Refinery Catalog, 22nd Edition.

Circle E5 on Postcard



Electronic Control Unit, announced by the Controls division of Manning, Maxwell & Moore, Inc., is designed for mounting on a standard radio relay rack and is available with prefabricated cable for connecting to other components in the manufacturer's "American-Microsen" Process

NEW DIMENSIONS



NEW SAMPLING SYSTEM OPERATES ON STEAM!

The new Hays Gaspirator* System is designed especially for difficult gas sampling problems involving high dust loading and high temperatures. It now permits accurate O_2 measurement, previously impossible in many applications.

This gas sampling system uses steam to obtain a continuous, clean sample. Suction which is created by the jet nozzle draws the sample in, where it is mixed with the steam. The steam is then condensed. Condensate and entrained solids drop down, and the sample is forced through the analyzer under pressure.

Hays, in the field of gas analysis for more than fifty years, developed the Gaspirator for use with their Magno-Therm Analyzer.

This analyzer, which operates on the paramagnetic principle, has for years been accepted as the leader in the field of O_2 measurement. Hundreds of companies are using the Magno-Therm and Hays electronic recorders very successfully in boiler plants and on process furnaces as a combustion guide, in regeneration of catalysts in refineries and in many other process applications.

For further details write for Bulletin 55-829-56.

*Patents pending.

THE hays CORPORATION

MICHIGAN CITY, IN. INDIANA

For more data on advertised products, use Readers' Service Cards, last page.

DOES THERMO ELECTRIC MAKE WIRE TYPE THERMOCOUPLES?

CERTAINLY. TRY AND NAME A THERMOCOUPLE T-E DOESN'T MAKE.

WIRE TYPE, PROTECTED THERMOCOUPLE

In Iron Constantan, Copper Constantan, or Chromel Alumel; mirror-polished protection tube resists chemical corrosion; for temperatures from as low as —300°F up to 2400°F, depending on calibration.

The wire type is one of many, standard, T-E thermocouples for taking process temperatures. Other kinds include tubular, bayonet immersion contact, exposed loop, and shielded.

Each careful step in their production, from calibrating to final testing, is handled in T-E's own plant. Our production facilities, combined with the skill and experience of our engineers, are at your service to develop special 'couples for unusual applications.

Furthermore, at T-E you can choose from a large selection of protection tubes — built-up or bar stock — in stainless steels and a wide range of other materials. Will we make special tubes? Of course.

Interested? Want the name of the T-E rep nearest you? Let us know, on your letterhead. Want more data? Ask for Catalog 22-X.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

New Equipment . . .

Control System. Rack-mounting simplifies problems of mounting and affords accessibility of control adjustment.

The controller uses the basic direct current signal of the manufacturer's American-Microsen System and need not be shielded from electrical interference. No voltage or temperature regulation is required to retain the inherent accuacy of the system. For further information . . .

Circle E6 on Postcard

Explosion Proof Enclosure Drain . . . A new stainless steel universal breather and drain has been announced by Crouse-Hinds Company. The new type ECD device is for use on explosion-proof combination starters and circuit breakers. Also, it can be used on other equipment housings in Class I, Group C and D hazardous locations. The unit contains larger air passages to prevent clogging due to dust and small dirt particles. The units can be installed in explosion-proof housings by screwing them into hubs or holes tapped for conduit having five or more threads. For further information . . .

Circle E7 on Postcard

Readout Device . . . Fischer & Porter Company offers a new conversion of a standard office electric typewriter to an automatic data reduction readout device. The unit permits high-speed, remote operation of typewriter keys and typewriter controls in response to coded electrical impulses. An optional tape punch attachment provides a five-hole, punched paper tape record suitable for feeding directly into computers or high-speed data processing equipment. The automatic typewriter provides a relatively low cost easily maintained versatile device for producing printed and

Get Accurate Viscosity Readings *IN MINUTES!*

NEW! TYPE II VISCOMETER

The Type II Viscometer has been developed to provide, *in a matter of minutes*, accurate, direct readings of kinematic viscosity of fuels, light oils, and non-corrosive liquids. The Type II uses a proven method based on advanced flow design. *No other laboratory instruments are required. Time-consuming equipment set-ups are avoided. No special operating skill is needed.*

Readability of the Type II is within 1% of indicated viscosity at any point on the scale. Its range of .5 to 5.0 centistokes includes *all* liquids used in testing aircraft fuel system components—making it ideal for use in the laboratory or field, or on new or existing test equipment!

Comes completely equipped as panel-mounted or portable. Widest possible range. Outstanding readability. Extremely simple to operate — no special skill needed.

Write for FREE Bulletin

Commercial Research Laboratories, Inc.

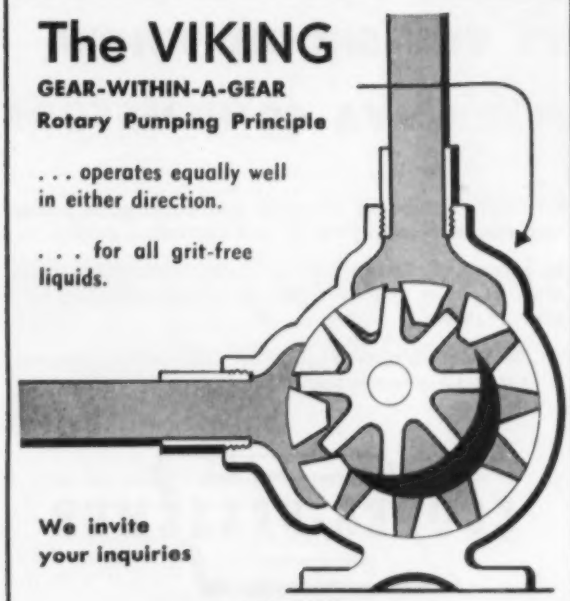
20 BARTLETT AVE. • DETROIT 3, MICH.

The VIKING

GEAR-WITHIN-A-GEAR
Rotary Pumping Principle

. . . operates equally well in either direction.

. . . for all grit-free liquids.



We invite your inquiries

DISTRIBUTOR

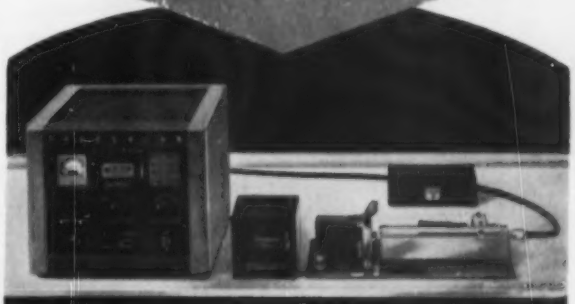
SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

HOUSTON • DALLAS • SAN ANTONIO • KILGORE • CORPUS CHRISTI • EDINBURG AND BEAUMONT, TEXAS

fast! simple! accurate!

determination of sulphur in hydrocarbons



Tracerlab's sulphur determination apparatus enables you to use the fastest method to determine accurately the sulphur content of hydrocarbons such as fuel oil and gasoline. With this new Tracerlab equipment, unskilled operators can determine sulphur content quickly, easily, precisely. Hence, sulphur determination can now be put on a wholly routine basis.

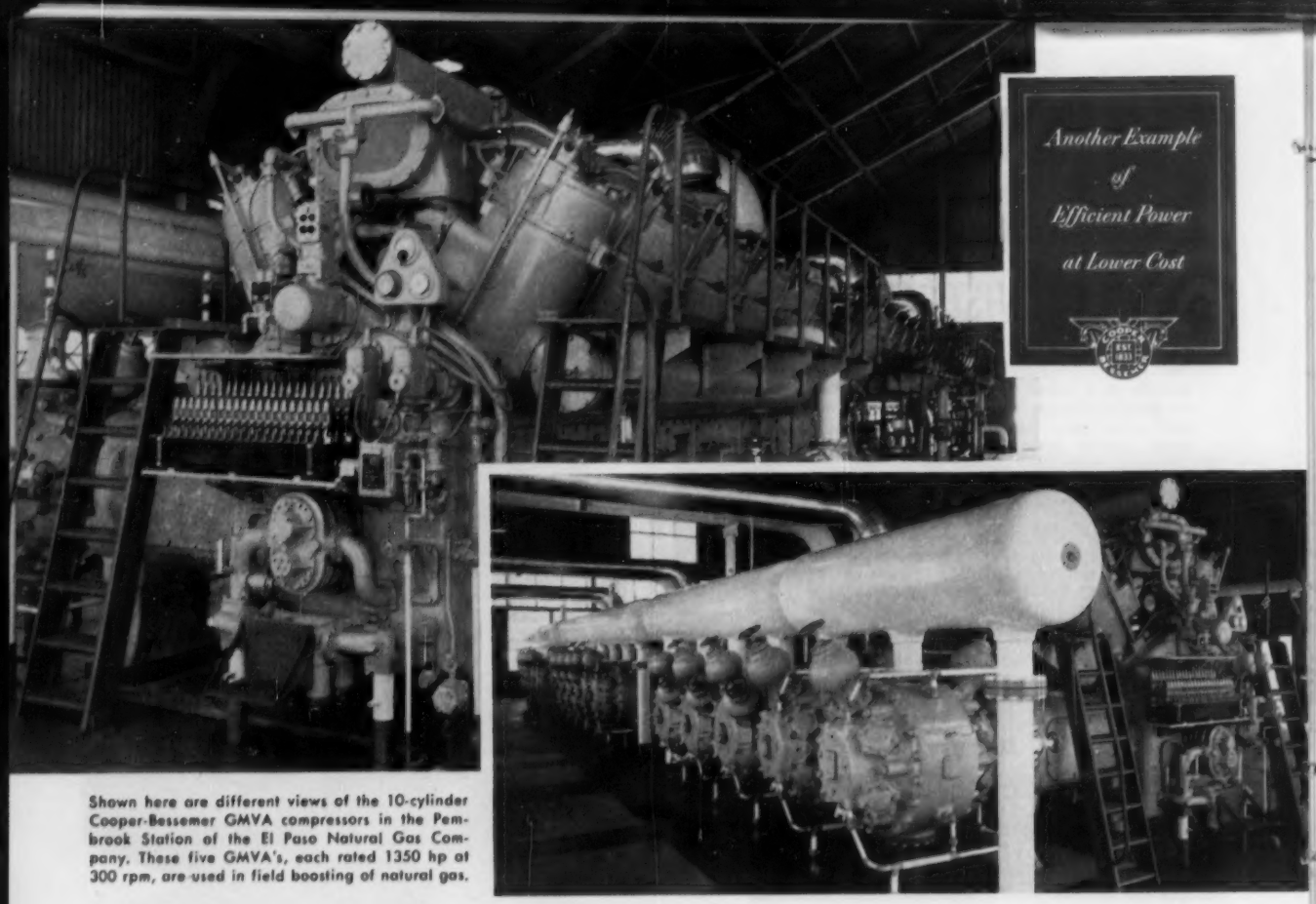
No longer is it necessary to employ complex X-ray diffraction apparatus and highly skilled, technically trained operators. The new Tracerlab equipment is compact, rugged and can be conveniently used in the field or the refinery with no need for a controlled laboratory environment. It operates on the principle of selective absorption of low energy radiation from an isotope source.

The equipment is low in first cost and can be completely amortized over a short period. Your inquiries are invited. Send for Bulletin P-104.

Tracerlab

130 High Street, Boston 10, Mass.
2419 South Boulevard, Houston, Texas
2030 Wright Avenue, Richmond 3, Calif.

WASHINGTON · NEW YORK
CHICAGO · CLEVELAND
PARIS · LOS ANGELES
PHILADELPHIA · OTTAWA



Another Example of Efficient Power at Lower Cost

Shown here are different views of the 10-cylinder Cooper-Bessemer GMVA compressors in the Pembrook Station of the El Paso Natural Gas Company. These five GMVA's, each rated 1350 hp at 300 rpm, are used in field boosting of natural gas.

10 MONEY-SAVING FACTS YOU SHOULD KNOW ABOUT NEW COOPER-BESSEMER GMVA COMPRESSORS

1. The new GMVA produces 35% more power than the original GMV; 23% more than the Turboflow type.

2. This power gain is accompanied by a full 25% reduction in fuel consumption over the original engine and 10% over that of the Turboflow type.

3. Improved fuel utilization means less heat is lost to jacket water and lube oil — more work!

4. Therefore the gain in power is obtained with no increase in exhaust temperature.

5. The improved power-to-temperature ratio reduces the demand for heat dissipation to water, permitting smaller auxiliary equipment.

6. Built-in centrifugal blowers, of Cooper-Bessemer design, provide greater scavenging air volume at low pressure for smooth, efficient performance at all loads and conditions.

7. With fewer parts, and components of improved design, the GMVA offers unmatched reliability, with minimum maintenance and part replacement.

8. Full-flow lube oil filtration assures complete protection against foreign particles and neutralizes acidity.

9. Improved design provides ample working space around power cylinders for simplified inspection and maintenance.

10. In short, minimum space per installed horsepower, with over-all economy and unexcelled performance.

MOUNT VERNON, OHIO

COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

Check all the cost-cutting factors . . . efficiency, service life, maintenance, installation cost, supervision, etc. . . . you'll find Cooper-Bessemer V-angles are your best bet for *better* compressor service. Write today to The Cooper-Bessemer Corporation, Mount Vernon, Ohio, for your copy of the new and complete GMVA Bulletin 75.

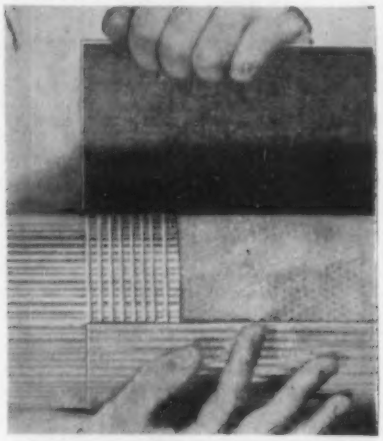
DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

New Equipment . . .

punched tape records of mass data and automatic control data reduction center.

Typed log sheets up to 26 inches wide can be automatically produced at speeds up to 10 characters a second. Since the combination does not alter the basic type writer mechanism, the manufacturer offers its standard guarantee and low cost service contract for repair maintenance for the typewriter section of the device. For additional information . . .

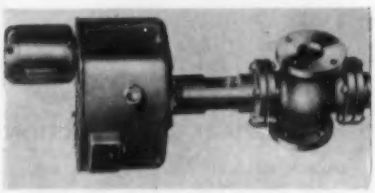
Circle E8 on Postcard



Aluminum Jacketing . . . Childers Manufacturing Company now offers jacketing in a series of eight ribs rolled into the underlapping edge called Lap-Seal. This two-inch ribbed edge is intended to provide a more positive weather seal and to permit ease of uniform Lap-Setting by the installing mechanic. For complete details . . .

Circle E9 on Postcard

This item supplements Childers Manufacturing Company data on page 244 of The Refinery Catalog, 22nd Edition.



Electro-Hydraulic Valve . . . Askania Regulator Company has developed an electro-hydraulic valve actuator for electronic controllers that increases the advantages of electronic control systems. The valve actuator is a complete self contained unit including control valve hydraulic power source, and proportional positioning mechanism which can be used with existing electronic controllers. Outside connections consist of the signal wires from the controller and an electric power supply. The signal current is applied to a high-resistance coil (3000 ohms or more) which moves in a magnetic field.

Linked to the coil is Askania's exclusive Jet Pipe which converts an electrical signal

To combat contamination . . .

UNION OIL USES HAMER

Main pump house manifold at Union Oil's Wilmington refinery uses hundreds of Hamer Line Blind Valves.

HAMER *Visible Shut-off* LINE BLIND VALVES

HAMER *Plug Valves*

Custom-crafted, Hamer Plugs welcome the tough applications where ordinary plug valves fall short. Standard dimensions. Readily installed.

With literally hundreds of different hydrocarbons moving through the refinery, Union Oil can't possibly risk product contamination. That's why they use Hamer Line Blinds. Hamer Line Blind Valves not only provide a permanent, positive leakproof shut-off, but are unsurpassed for long service-life and lasting safety. In addition Hamer Line Blinds are fast, simple to operate. One man can open or blind a line in one minute. Costly down time is reduced. Operational efficiency is vastly increased.

HAMER

Send for FREE Catalog

VALVES, INC.

2919 Gardenia Ave., Long Beach 6, Calif.

Representatives throughout the World

REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

The
HARVEY LINE
proudly offers
HONOLULU • TAHITI • ACAPULCO
CRUISES

LUXURIOUS STEEL YACHT

48 day cruise of the South Pacific with stop overs in Hawaii, Christmas Island, Tahiti, Acapulco. See Tahiti the Gem of the Pacific in all its grandeur. Four regular sailings yearly.

SPECIAL OLYMPIC GAME CRUISE

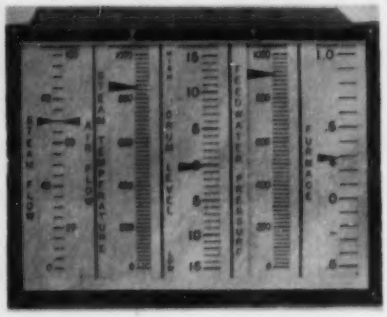
Departure from Los Angeles Oct. 1, 1956 for Melbourne, Australia — stopping in route: Honolulu, Samoa, Fiji, New Caledonia, and Sydney. Live aboard ship in Melbourne during games. On return home, stops are made at Auckland, New Zealand, Cook Island, and Tahiti. Return to Los Angeles Dec. 22. Make reservations now to assure seats at the Olympic Games — Limit 36 passengers.

FOR INFORMATION WRITE
THE HARVEY LINE
5422 LEMON GROVE
HOLLYWOOD, CALIF.
HO 9-1450

New Equipment . . .

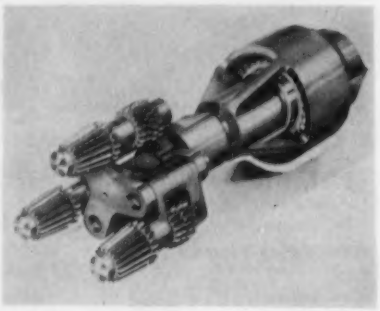
of less than 50 milliwatts into the powerful stroke of a control valve. The valve moves at a speed of better than one inch per second. Thrusts of 600 pounds and more can be handled, with strokes presently available up to 2 inches. For additional information . . .

Circle E10 on Postcard



Small-Size Instruments . . . Republic Flow Meters Company announces a new line of small-size receivers and draft, pressure and temperature gages that permit more compact instrument panels. Called the V5 series, the new indicating instruments have scales that are only five inches high, yet, because of their unique design and illumination, are easy to read from a distance. Each gage or receiver is an independent in a self-contained unit and may be grouped together with as many as eight other units in a single case or mounted individually. For additional information, just . . .

Circle E11 on Postcard

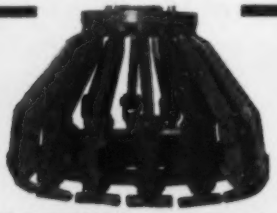


Water Driven tube cleaner has been developed by Airetool Manufacturing Company for use in tube cleaning applications where availability of air or steam to drive the operating motor is inconvenient. The water driven motor is designed for use with either high or low pressure and will operate on far less pressure and will operate on far less pressure than similar motors heretofore available. It is 75 percent more powerful in operation than previous models but produces essentially the same results. Since this motor assembly is shorter than other types, it works well in curved tubes and can be used on sizes from 1½ inches to 4 inches I.D. To get full information on this new unit . . .

Circle E12 on Postcard

Hex Steel Attachment Devices have been developed by George P. Reintjes Company. These attachment accessories are intended to simplify the problem of attaching refractory liner hex steel sections in vessels such as reactors, and regenerators and to improve the pneumatic insulation placement characteristics of such installations. The attachments also permit free motion of the hex steel sections from thermal defects. For further information . . .

Circle E13 on Postcard



BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
• No operator required.
• 100% air operated.
Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.
BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas
4330

TEMPORARY STRAINERS

SANDUSKY MAC-IRON OHIO
Established 1901

Made by a skilled mechanic and not by "just some guy with a torch."

REVOLUTIONARY CONSTRUCTION

Smooth, efficient contours . . . no weld "blob" around edge of ring. The flange is precision rabbeted into the ring joint gasket making deformation at that point impossible.

MAC-IRON offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges.

A large stock on hand is maintained; special strainers made to specification. Write direct for a catalog and complete information.

The Mack Iron Works Company
Warren and Water Sts. Sandusky, O.

PRESSURE VESSELS

FOR

PETRO-CHEMICAL PLANTS

You can use the wide experience of St. Mary Iron Works when you build pressure vessels. Our thoroughly experienced staff of designers, engineers and fabricators will furnish the equipment you need. Consult us before you start new construction.

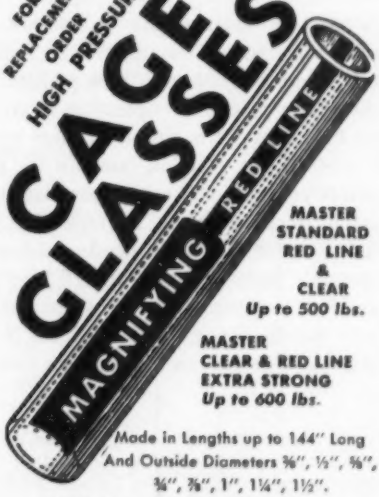
ST. MARY IRON WORKS

Steel Fabricators for Half a Century

FRANKLIN, LOUISIANA

FOR REPLACEMENTS ORDER HIGH PRESSURE

GAGE GLASSES



MASTER STANDARD RED LINE & CLEAR
Up to 500 lbs.

MASTER CLEAR & RED LINE EXTRA STRONG
Up to 600 lbs.

Made in Lengths up to 144" Long
And Outside Diameters ⅜", ½", ⅝", ¾", ⅞", 1", 1¼", 1½".

High Pressure Composition

ERNST RUBBER GASKETS

All sizes to fit your gages and valves

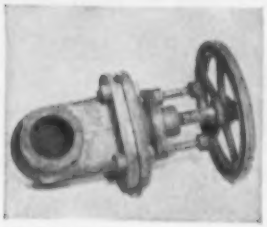
FIG. 21—Lip Mold

FIG. 22—Standard

ERNST WATER COLUMN & GAGE CO.

Send for Catalog — LIVINGSTON, N. J.

Costly Replacement?



Not at ALL!

Just Simple Reconditioning with Amazing Oakite

RUSTRIPPER

Think of it! With a *single* tank of this great new alkaline material, you can *simultaneously* remove rust, grease, dirt, and paint from pipes, valves, fittings, and literally hundreds of other salvageable parts! In *one* simple operation, remarkable Oakite RUSTRIPPER cleans right down to the bare metal — yet, unlike dangerous raw acidic materials, it doesn't attack sound surfaces or cause toxic odors. It doesn't require special stainless steel tanks or costly protective equipment. You can use it just as you would any highly alkaline material — but the *results* will amaze you:

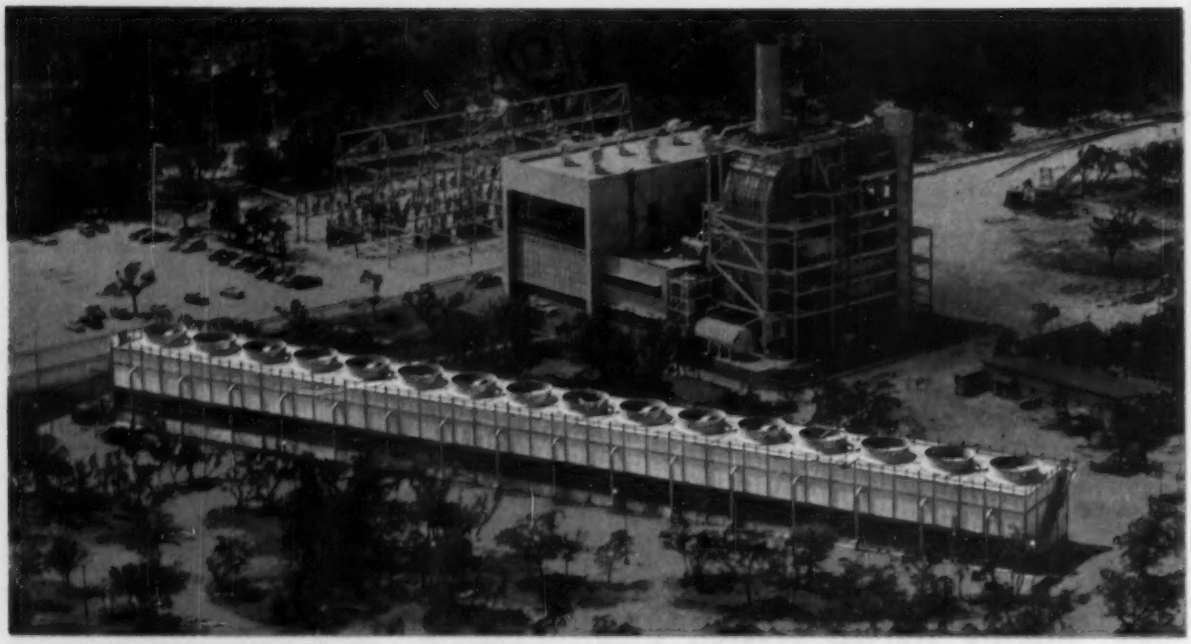
One Ohio refinery estimates salvage savings in excess of $50,000 a year since Oakite RUSTRIPPER has been on the job!

Like to know exactly how Oakite RUSTRIPPER can fit into *your* operation? Your nearby Oakite Petroleum Representative will gladly provide you with all the details. Or, if you prefer, ask for FREE illustrated folder that gives complete information. It's yours with no obligation. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

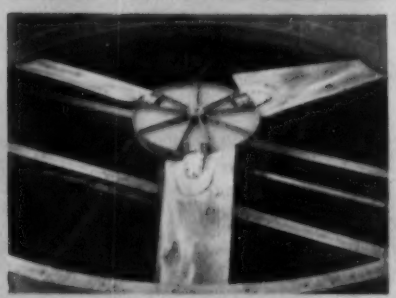
SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

Export Division
Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada



37 Hartzell 18′ Cooling Tower Fans help insure uninterrupted power production at San Antonio's W. B. Tuttle and Leon Creek power plants



Hartzell cooling tower fans play an important role in helping the City Public Service Board meet the growing power demands of the San Antonio area. Hartzite plastic fans are used exclusively on the 16 cell tower at the new W. B. Tuttle power plant and on two towers at the Leon Creek plant.

Continuous, low maintenance fan operation to insure uninterrupted cooling tower service is vital to refinery operations, too. That's why trouble-free Hartzell fans are the choice of the petroleum industry. That's why, where one Hartzite plastic fan has been installed on a tower, "Hartzell" is almost invariably specified as additional fans need replacement.

To get the complete story on how Hartzell fans can help you get better service from your cooling towers and heat exchangers, call your nearby Hartzell field engineer or drop us a line. Do it today. And be sure to ask for your free copy of Bulletin A-112.

The Hartzell cooling tower installations at San Antonio's City Public Service Board power plants were handled by the Hartzell field office at 5717 Kirby Drive, Houston, Texas; phone Jackson 3-4565.

HARTZELL

Dept. K

PIQUA, OHIO

propeller fan co.

Div. of Castle Hills Corp.

ENGINEERING OFFICES IN PRINCIPAL CITIES

PROPELLER-TYPE FANS • BLOWERS
ROOF VENTILATORS • UNIT HEATERS

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Polyvinyl Chloride Pipe and Fittings . . . Haveg Corporation has just published a new 12-page brochure on Fabricated Haveg 1810, an unplasticized chemical resistant polyvinyl chloride. The brochure contains complete specifications, including dimensional charts, on Haveg 1810 pipe and pipe fittings, fume duct and fittings, dampers, weather caps and valves. It also covers special fabricated items. For your free copy of this bulletin . . .

Circle E14 on Postcard

Weld Fittings . . . . A new 21-page manual provides detailed data on five Ladish fittings developments for pipe line and petroleum industry applications. Numerous photographs, sketches and engineering drawings are used to illustrate design advantages and savings resulting through use of these new fittings. Developments covered include Hot Tap Reinforcing Tees, Multiple Outlet Headers, Extra Long Radius Elbows, Pipe Line Anchor Flanges, and Seamless Multiple Outlet Headers. For your copy . . .

Circle E15 on Postcard

Radio Chemicals . . . General Chemical Division, Allied Chemical and Dye Corporation has published a special 24-page booklet on radioisotope reagents. The book contains an introductory section giving background information on what radiochemicals are and how they are used in industrial research. Listed are more than 130 organic and inorganic radiochemicals which General Chemical offers. These include Carbon-14 labeled compounds and deuterated compounds. The chemicals are available as part of the Baker and Adamson line of Laboratory Reagents and Fine Chemicals. For your copy . . .

Circle E16 on Postcard

Packaged Steam Generators are comprehensively covered by Foster Wheeler Corporation's 16-page catalog covering 10,000- to 46,000-pound-an-hour units. This bulletin gives capacities, dimensions, construction features, instrumentation, accessories, sectional drawings, and also illustrative photographs.

Also included is a chart for selection of firing equipment and controls and a typical proposal form. To obtain this information, just . . .

Circle E17 on Postcard

Ductile Ni-Resist is covered by an International Nickel Company publication including seven tables and two figures. Ductile Ni-Resistine is a new engineering material that combines the strength and ductility of ductile cast iron with the resistance to corrosion, heat, and metal-to-metal wear possessed by conventional Ni-Resist castings. The paper compares properties of conventional and ductile No-Resist irons and summarizes present and potential industrial applications. For your copy . . .

Circle E18 on Postcard

Instrumentation . . . The Bristol Company has just released two new publications covering their pH recorders and controllers for use with Beckman electrodes and amplifiers and a new line of 6 inch strip chart recorders for pressure, liquid level temperature flow and mechanical motion. Included in the pH recorder data is Bristol's new fully portable unit which is self powered and ruggedly designed for field use or for laboratory use where permanent installation is not justified. For your copies of the pH instrument data bulletin Q1305 or for the 6 inch strip chart recorder data . . .

Circle E19 on Postcard

Specialty Steels . . . A new 32-page illustrated guide to Specialty Steels has been published by Carpenter Steel Company. The booklet defines the distinctive characteristics of a broad range of special purpose steels in terms of end use. It briefly summarizes the Carpenter specialty products covering stainless steels, silicon and high nickel electrical alloys, special purpose alloy steels, valve, heat-resisting and super alloy steels, tubing and pipe in various analyses and corollary information on manufacturing quality control. To get your copy . . .

Circle E20 on Postcard

Stream Blending and Injection . . . Proportioneers, Inc., Division of B-I-F Industries, Inc., has issued two technical bulletins covering automatic proportioning and blending of lead to gasoline and injecting petroleum additives. Both bulletins cover schematic installations, discussion of methods and complete descriptive information. For your copies . . .

Circle E21 on Postcard

Portable Potentiometers . . . Leeds & Northrup Company has made available a new data sheet on its portable potentiometers. Contained is complete information about single, double and triple range potentiometers which are widely used for numerous emf measurements in plant and laboratory. Listed are instrument features and characteristics of each potentiometer for ready comparison. For your copy of L & N Data Sheet E-51 (2), just . . .

Circle E22 on Postcard

Fume Scrubbers . . . Schutte and Koerting Company has just released a new 12-page bulletin covering the use of fume scrubbers for pollution control. Complete technical details on fume scrubbers and "packaged" scrubbing systems are included. The equipment employs water or other suitable liquid as the scrubbing agent for the control of fumes or dust and is adaptable for the handling of solid particles, liquid particles, or gases. A thorough discussion of scrubbing problems and methods employed is included. Just . . .

Circle E23 on Postcard

Hydraulic Equipment is completely described in a new 56-page catalog, No. 5001A, published by Vickers, Inc.

The new catalog includes engineering, design and applications information relating to pumps, pressure controls, volume controls, directional controls, control assemblies, hydraulic motors, transmissions, cylinders and hydraulic accessories.

Each category includes descriptions of the various units which make up that group; the section on pressure controls, for example, covers relief valves, sequence valves, unloading valves, counterbalance valves, pressure reducing valves, and pressure switches.

Each unit is described in detail with photographs, cutaway views and typical circuit drawings as are required to explain the operation. Also given are application recommendations and pertinent data on the devices. For a copy of this bulletin, just . . .

Circle E24 on Postcard

Publications Index . . . Prepared by Diamond Alkali Company is a convenient compilation of Diamond publications that are available to the industry. This index covers a number of technical writings.

Circle E25 on Postcard

Advertisers in October Issue

A

*The Air Preheater Corp. 265
*Airetool Manufacturing Co. 234
Allied Chemical & Dye Corp. 9, 39, 284
*Allis-Chalmers Manufacturing Co. 11
*Alloy Steel Products Co. 81
*Aluminum Company of America 21, 79, 253
*American Brass Co. 209
American Cyanamid Co.
Refinery Chemicals Department 7
*American Machine & Metals, Inc. 195
The V. D. Anderson Co. 264
Ansul Chemical Co. 212
Automatic Electric Co. 74
Automatic Sprinkler Corp. of America 238

B

*The Babcock & Wilcox Co. 73, 92
*The Babcock & Wilcox Co.
Tubular Products Division 59
*Badger Manufacturing Co. 90
Barrett Manufacturing Co. 302c
Bingham Pump Co. 16
*Black, Sivalls & Bryson, Inc. 248
*Blaw-Knox Co. 47
The Bristol Co. 183
*Brown Fintube Co. 84
Bucyrus-Erie Co. 83
*Buell Engineering Co. 227
Burgess-Manning Co. 282
Burrell Corp. 188

C

*G. O. Carlson, Inc. 280
*The Carpenter Steel Co. 78
*Catawissa Valve & Fittings Co. 213
The Chapman Valve Mfg. Co. 211
Chase Brass & Copper Co. 42
Chemical Construction Corp. 249
Chemical Industries Exposition 286
Chicago Bridge & Iron Co. 86
Cities Service Co. 70
*Clark Bros. Co. 30, 31
Classified Advertising 288
Climax Molybdenum Co. 82
Columbia-Geneva Steel Division
United States Steel Corp. 37, 54
Commercial Research Laboratories, Inc. 279a
*The Cooper-Bessemer Corp. 300
*Corning Glass Works 258a
*Crane Co. 179
*Crane Packing Co. 237

D

*Dean Bros. Pumps Inc. 214
De Laval Steam Turbine Co. 65
Delta Engineering Sales Co. 220
*Dollinger Corp. 215
Dowell Incorporated 231
*Dresser Industries, Inc. 30, 31, 247
The Ducon Co. 222
E. I. du Pont de Nemours & Co. 98, 273, 274
*The Duraloy Co. 218
Durametallic Corp. 275b

E

The Eagle-Picher Co. 66
The Electric Controller & Mfg. Co. 241
*Elliott Co. 192, 217
*Ernst Water Column & Gage Co. 303b
Ethyl Corp. 100, 101

F

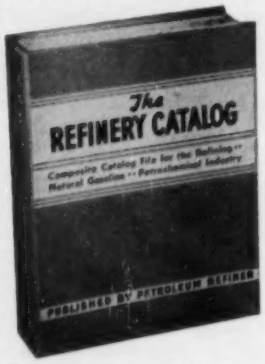
Fenwal Incorporated 223
Fischer & Porter Co. 219
*Fisher Governor Co. 12
*Flint Steel Corp. 276
*The Fluor Corp. 251
*Food Machinery & Chemical Corp. 13
The Foxboro Co. 290a
*Foster Wheeler Corp. 8
The Foxboro Co. 277

G

*General American Transportation Corp. 193
General Chemical Division
Allied Chemical & Dye Corp. 9
*General Electric Co. 243, 244, 245, 246
General Refractories Co. 63
The Girdler Co. 91
A. P. Green Fire Brick Co. 38
*The Gulf Publishing Co. 295b
Gunite Concrete & Construction Co. 289b
Gustin-Bacon Manufacturing Co. 58
Gutehoffnungshuette 290a

H

*Hamer Valves, Inc. 301
The Harshaw Chemical Co. 235
Hartzell Propeller Fan Co. 304


The
REFINERY CATALOG
Complete Catalog File for the Refining -- Natural Gasoline -- Petrochemical Industry
PUBLISHED BY PETROLEUM REFINER

*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1955 Refinery Catalog.

The Harvey Line 302b
Haveg Corp. 61
The Hays Corp. 297
Hercules Powder Co. 57
*Homestead Valve Manufacturing Co. 49

I

*Ingersoll-Rand Co. 229
*International Engineering, Inc. 281
The International Nickel Co. 207, 287
*Irving Subway Grating Co. 252

J

Jefferson Chemical Co. 87
*The C. O. Jelliff Mfg. Corp. 295a
*Johns-Manville Corp. 64
*Jones & Laughlin Steel Corp.
Supply Division 51

K

*The M. W. Kellogg Co. 18-19
C. M. Kemp Mfg. Co. 50
*Klemp Metal Grating Corp. 290b
*Richard Klinger Ltd. 197
Koppers Co. 232

L

Laclede-Christy Co.
Division of H. K. Porter Co. 191
Larkin Packer Co. 77
Lawrence Pumps Inc. 224
Layne and Bowler, Inc. 233
Layne & Bowler Pump Co. 216
Lukens Steel Co. 68
*The Lummus Co. 52, 189

M

*The Mack Iron Works Co. 302d
Manning, Maxwell & Moore, Inc. 76
Clayton Mark & Co. 275a
The Marley Co. 48
*Mason-Neilan Regulator Co. 25, 26, 27, 28
The Master Electric Co. 46
*A. Y. McDonald Mfg. Co. IV Cover
*Arthur G. McKee & Co. 88
*Milton Roy Co. 53
*Minerals & Chemicals Corp. of America 29
*Mixing Equipment Co. 96
*Murray Iron Works Co. 228

N

National Tube Division
United States Steel Corp. 54
Newport News Shipbuilding & Dry Dock Co. 75
*Nitrogen Division
Allied Chemical & Dye Corp. 39, 284
*Norton Co. 221

O

*Oakite Products, Inc. 303c
*Orbit Valve Co. 67

P

*Pacific Pumps, Inc. 296
The Patterson Foundry & Machine Co. 89
*Peabody Engineering Corp. 270
*Peerless Pump Division
Food Machinery & Chemical Corp. 13
The Permutit Co. 258b
*Petreco
Division of Petrolite Corp. 43
*Petro-Chem Development Co. 62
*Petroleum Refiner 40-41
*The Pfaudler Co. 80
*Phelps Dodge Copper Products Corp. 14-15
Pittsburgh Corning Corp. 259
*H. K. Porter Co., Inc. 285
The Wm. Powell Co. 85
Precision Thermometer & Instrument Co. 289c
*The Pressed Steel Co. 254b
J. F. Pritchard & Co. 72, 255

R

The Refinery Engineering Co. 32
Geo. P. Reintjes Co. 289a
*Revere Copper and Brass Inc. 177
Reynolds Metals Co. 292
Rheem Manufacturing Co. 267
Phodia, Inc. 278
The Ridge Tool Co. 293
*Rockwell Manufacturing Co. 35, 36
*Rockwood Sprinkler Co. 95, 263
*Roots-Connersville Blower Corp. 247

S

St. Mary Iron Works 303a
*Sarco Co. 181
*Scovill Manufacturing Co. 6
*M. B. Skinner Co. 302a
A. O. Smith Corp. 256, 257
Southern Engine & Pump Co. 299b
Standard Oil Co. of California 236
*Stone & Webster Engineering Corp. 69
*Strong, Carlisle & Hammond Co. 194
*Sun Shipbuilding & Dry Dock Co. 271

T

*Taylor Instrument Companies 186, 187
Tennessee Coal & Iron Division
United States Steel Corp. 37
Tennessee Corp. 254a
*The Terry Steam Turbine Co. 56
Thermo Electric Co. 298
Arthur Tickle Engineering Works 295c
The Timken Roller Bearing Co. 10
Titeflex Corp. 268, 269
Tracerlab, Inc. 299c
*Tretolite Co. 35, 71
*Tube-Turns, Inc. 239, 240
*Tubular Products Division
The Babcock & Wilcox Co. 59

U

Union Wire Rope Corp. 283
United States Gauge Division
American Machine & Metals, Inc. 195
*United States Rubber Co. 45
United States Steel Corp. 37, 54
United States Steel Export Co. 37, 54
United States Steel Supply Division
United States Steel Corp. 37
*Universal Atlas Cement Co. 24
Universal Oil Products Co. 260, 261

V

Visco Products Co. 185
*Henry Vogt Machine Co. 60
J. H. H. Voss Co. 262b

W

Wagner Electric Corp. 44
Walworth Co. 20
Warren Petroleum Corp. I Cover
*Watson-Stillman Fittings Division
H. K. Porter Co. 285
Wedgeplug Valve Co. 17
West Instrument Corp. 262a
*Western Supply Co. 55
*Weston Electrical Instrument Corp. 34
*The Whitlock Manufacturing Co. 294
Williams Gauge Co. 190
*Worthington Corp. 22, 23, 279
Wyatt Metal & Boiler Works III Cover

Y

*Yarnall-Waring Co. II Cover
*Otto H. York Co. 250

Z

*Zallea Brothers 225

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.
2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

•

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS, U. S. A.

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

PETROLEUM REFINER Readers' Service Card — October, 1955, Issue*

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25											

ADVERTISEMENTS—Circle page number of ad for more product information:

1	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	95	96	95	177	179	181	183	185	186	187	188
189	190	191	192	193	194	195	197	207	209	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	227	228	229	231	232	233	234	235	236	237	238	239	240	241	242
243	244	245	246	248	249	250	251	252	253	254a	254b	255	256	257	258a	258b	259	260	261
262a	262b	263	264	265	266	267	268	269	270	271	273	274	275a	275b	276	277	278	279	280
281	282	283	284	285	286	287	289a	289b	289c	290a	290b	292	293	294	295a	295b	295c	296	297
298	299a	299b	299c	300	301	302a	302b	302c	302d	303a	303b	303c	304						

Name (Please Print)_____

Company_____ Position_____

Address_____

*OCT. ISSUE CARD EXPIRES DEC. 31, 1955 — Check Square for Extra Card ☐

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.
2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

PETROLEUM REFINER Readers' Service Card — **October, 1955, Issue***

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25											

ADVERTISEMENTS—Circle page number of ad for more product information:

1	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	95	96	98	177	179	181	183	185	186	187	188
189	190	191	192	193	194	195	197	207	209	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	227	228	229	231	232	233	234	235	236	237	238	239	240	241	242
243	244	245	246	248	249	250	251	252	253	254a	254b	255	256	257	258a	258b	259	260	261
262a	262b	263	264	265	266	267	268	269	270	271	273	274	275a	275b	276	277	278	279	280
281	282	283	284	285	286	287	289a	289b	289c	290a	290b	292	293	294	295a	295b	295c	296	297
298	299a	299b	299c	300	301	302a	302b	302c	302d	303a	303b	303c	304						

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

Name (Please Print)_____

Company_____ Position_____

Address_____

*OCT. ISSUE CARD EXPIRES DEC. 31, 1955 — Check Square for Extra Card ☐

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS, U. S. A.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services

Wyatt's... Floating Roof

....Its Seal fits the Shell regardless of Size or Configuration!

IT ASSURES...

- **Less Evaporation**
- **Less Corrosion**

. . . all the advantages and the mechanical advancements in WYATT'S FLOATING ROOF for the storage of crude oil and its products are contained in Brochure FR-R

Write to: WYATT METAL & BOILER WORKS
P. O. BOX 3052
HOUSTON, TEXAS

Wyatt's
HOUSTON-DALLAS-NEW YORK-TULSA

MANUFACTURERS AND ERECTORS SINCE 1913

Of course you want a fill tube that prevents overflow and vapor leakage—it's too costly and dangerous to be without one. There are many fill tubes that will do, but—

Only McDonald gives you a fill tube with all these advantages

McDonald's Vapor-Tite Fill Tube is inserted as shown in Figure 1. When the lever handle is pressed down the composition sealing sleeve expands forming a vapor tight seal. Figure 2.

McDONALD'S VAPOR-TITE FILL TUBE (Plate 236) Leading oil companies now exclusively using the McDonald Vapor-Tite Fill Tube have proved its superior protection, convenience and flow volume. 2, 3 and 4 inch sizes available.

FITS ALL STANDARD FILL OPENINGS No need to make new expensive installations, the McDonald Vapor-Tite Fill Tube fits snugly and easily into all standard type fill boxes.

SPECIAL DESIGN INCREASES FLOW VOLUME Don't let that elbow fool you — special McDonald design eliminates any restrictions — actually *increases* the volume of flow. Hook one up and count those extra gallons per minute yourself . . . make your own comparison.

INSTANT OVERFLOW CHECK Just crack the lever handle slightly. If any liquid appears in the fill pipe, snap the handle back in place — you won't spill a drop.

LIGHTWEIGHT McDONALLOY CONSTRUCTION McDonalloy — one of the strongest, most corrosion-resistant aluminum alloys known — stands more abuse than brass with only ⅓ its weight. A 2-inch fill tube weighs only 4¼ lbs.

If you want a fill tube for practicability, economy, speed in delivery and safety, plate 236 is your answer. Contact your nearest oil equipment dealer or write for information.

A. Y. McDONALD MFG. CO.

Dubuque, Iowa

Oil Equipment Division

EST. 1884 McDonald